JAN 18 1923
JAN 16 1923
Chemical Library

Transactions of American Society for Steel Treating

Published Monthly | Cleveland, January, 1923 | Ten Dollars a Year
Vol. III | *Entered as second-class matter Feb. 7, 1921, at the post-office at Cleveland, Ohio, under the Act of March 3, 1879* | No. 4

SPECIAL FEATURES

Editorials 361

Recent Researches on the Elastic Limit— *Herman A. Holz* 367

Carbide Segregation in High Speed Steel— *A. E. White* 386

The Executive and Research— *Dr. J. A. Mathews* 393

Gas Useful in Heat Treating Room— *J. Weaver Smith* 396

Some Fundamentals of Research— *F. O. Clements* 415

The Heat Treatment of Cast Steel for Hydroelectric Power Machinery— *Dr. B. Egeberg* 422

The Need for More Practical Information in Industry— *Dr. J. S. Unger* 430

A Metallographic Study of Hollow Rock Drill Steel as Influenced by the Method of Manufacture— *Dr. N. B. Hoffman* 436

Table of Contents, Page 33

Copyright 1923, American Society for Steel Treating

4600 Prospect Avenue

Charging Floor Scene—Central Steel Company

Ask Yourself the Question—Is *it IN the Steel?*

THAT extra quality which you are seeking for your product—that super-excellence which will make the article stand out clearly and distinctly in the trade—where shall you look for it? How shall you achieve it? Is it IN the steel?

Sooner or later this problem in steel must come to every progressive manufacturer who uses steel as an important raw material. Agathon Alloy Steels may provide a quick and sure solution. Hundreds of thousands of tons of these good steels are going into various lines of manufacture every year to make better gears, springs, shafts, forgings, etc. We have the records of hundreds of adaptations, some one of which may parallel your case. We daily produce all standard and many special analyses of alloy steels and ship in blooms, billets, bars, slabs or hot-rolled strips.

Our Research Laboratories will gladly work with you on the development of the exact analysis of alloy steel that will meet your particular requirements.

Ask for a Copy of Our Booklet, "Agathon Alloy Steels"

THE CENTRAL STEEL COMPANY, Massillon, Ohio

Swetland Bldg. Cleveland | Book Bldg. Detroit | Peoples Gas Bldg. Chicago | University Block Syracuse | Widener Bldg. Philadelphia

AGATHON ALLOY STEELS

TRANSACTIONS

of the

American Society for Steel Treating

Vol. III Cleveland, January, 1923 No. 4

NINETEEN TWENTY-THREE

AS WE enter the threshhold of this New Year the Society extends its greetings to all members and expresses the hope that the record of achievements for the members and the Society will mark the greatest advancement in 1923 of any year. Each of us has an important work to do in 1923, and we will be judged by the records of our achievement. Each individual member has it within his power to contribute to the advancement of society. This part may be in any number of ways, either by increasing efficiency, thus increasing production or by investigating, and stopping avenues of waste that may be discovered. If this contribution for 1923 does not find expression in increased efficiency in your own department, it may find expression in contribution to the welfare of the steel treating fraternity. This possible contribution may be either by a paper presented before a Chapter, Sectional or National meeting or by a discussion of some interesting topic that may be instrumental in bringing valuable assistance to some member of the Society. In this way, you have not only been of great help to others, but you will also find much satisfaction in the thought that you have been of service. It may be that a portion of this service for 1923 may find expression as a member of some of the National Committee, or as a member of a local chapter committee. If that is the case, great energy applied to the accomplishment of the problems placed before you will contribute materially to the continued rapid and pronounced advancement of the Society.

It is a well recognized fact that the Society owes its members a service, and while a service has been given that is greater in scope and volume than even the oldest members might have hoped for, yet every effort will be extended to increase that service in 1923. The last two years have marked an advance in the accomplishments of the National Society, which is a point of just pride for all. Nevertheless, there is no reason for self-satisfaction, and we feel justified in stating that your Board of Directors will lend every effort in order that the Society may accomplish what it is intended should be accomplished, and that these accomplishments may be of great and inestimable value to its members.

The purpose of the A. S. S. T. is educational and not for profit, except that profit which means increased educational advancement of its members and for all of the users of steel. The A. S. S. T. is a co-operative institution. Co-operative in the sense that it is a joint working organization of all, with each classification having its special work to do, and the degree of energy with which this work is done will be the slide rule by which its percentage of accomplishments is measured.

So let us enter into 1923 with a steadfast purpose and maintain all

MEETING OF BOARD OF DIRECTORS OCT. 27, 1922

through the year the same spirit with which we begin. Let us all do the work that is assigned to us to the best of our ability, so that when 1923 closes its books we shall find entered upon the pages credit for having done the best within us. The future holds great possibilities for increased usefulness, and the manner in which we make use of the talents given us will be the degree by which success or failure will be measured.

Let it be Success.

MAKING A CHANGE

CLAUDE W. SUTTON, who at the age of 39 became president of a large concern in whose employ he had entered four years previous, writes very entertainingly and interestingly in the December *American* with reference to knowing when to leave a job, as well as when to take one. "An ambitious man" says Mr. Sutton, "will hold three or four, maybe a dozen, jobs, before he reaches one that exactly fits or which he can alter to fit. In fact, very rarely is a man under thirty serving his own best interests by holding on to one job, or even one kind of a job beyond a reasonable period. He needs contact with various kinds of organizations before he really knows what he is or what he wants. He can use these jobs to gain experience and not care at all about the good will. If he does not care about the good will, he makes every future step forward unnecessarily difficult. He has to bother about getting new jobs, instead of having them offered him. Then, when he gets placed, a crowd at once turns up to knock him."

The author in the article points out that a man who gets fired, or leaves, hardly ever misses an opportunity to get something off his mind. He thinks he is a poor weakling if he does not do something to help out his pride, but if the individual uses the proper amount of discretion, he will take particular care to see that he does not make any enemies upon leaving a position. It is an important item that the good will which an individual builds up in an organization should remain with the firm after he has taken his departure. No doubt a great number can recall really first class individuals who are out of work, yet who ought to be working, because their ability is considerably above the average. They are all men between forty and fifty, the age at which a man is always at his best. They are out of work solely because they have never left a job without a row. Not one of them ever left a job except with his head in the air with defiance sticking out all over him. Always, in the next job, a man works his fingers off to get the business of his former employer, and now people are afraid to hire them.

We are inclined to agree with Mr. Sutton in a great many of his statements. Yet there is a feeling common to all of antipathy toward changing satisfactory and congenial environments in an endeavor to find other lines of work that might be somewhat more pleasant. It is quite probable too that an individual thirty years of age is and should be happily married and consideration must be given to conditions best fitted to promote the interest of his family. The large majority of individuals are not of a roving disposition, but purchase property in the town where they are located, place their children in school; their family becomes acquainted and form friendships that requires more than a money consideration to destroy. Where the worth of an individual is properly recognized and working conditions are satisfactory, it is doubtful if all the advice contained in the article relative to changing to so many positions, is desirable of fulfillment.

MEETING OF BOARD OF DIRECTORS OCT. 27, 1922

ARE YOU A LIABILITY?

DURING the recent industrial depression it became necessary for a great many firms to curtail expenses. The rapidity with which they discontinued the services of men in their physical and chemical laboratories was surprising and alarming. It seemed that those in authority did not realize the real value to their organization of these departments and consequently had the least hesitancy in quickly disconnecting them from the payroll. One gathers the impression that the reason for this was due primarily to the men themselves, inasmuch as they probably had not taken an opportunity to prove to the management that the physical and chemical laboratories and metallurgical departments were an asset in place of a liability. It does not require a cost accountant to determine whether or not your department is making a profit. While you may be confident that your department is registering on the proper side of the ledger, nevertheless, it is always advisable to have it in actual figures and in black and white. Those in charge of a department should know the exact cost of each day's operation and within the fraction of a cent the exact cost of each individual operation. To do this might appear to be a large undertaking, but by an analysis of your department and a conference with the proper authority, the direct overhead charges can be readily ascertained, and the question of figuring your costs from day to day should involve a minimum amount of work and should be considered a necessary part of your activities.

Your company should know, and you should know that at your present salary they are getting back the money they pay you. They should realize that they are not only getting back the money they pay you, but they are making money on you. If you could prove to the company that they are making money on you, your future should be quite certain. If the company should wake up some day and prove that it is losing money on you, your job is in peril, and justly so, but you are the one most interested, and you should be studying your case continuously. Do not drift along waiting for the company to analyze the work in your department, be analyzing it yourself from day to day, so that when the management calls for a conference, you will be able to show them that your department has not only been turning in a profit, but has been conducted on a most economical basis.

Analysis not only of the individual, but of a department will be the best means of preventing in the next industrial crisis a return of the wholesale elimination of valuable employees in the physical, chemical and metallurgical laboratories.

PITTSBURGH SELECTED FOR 1923 CONVENTION

The Board of Directors of the American Society for Steel Treating, after having given the location of the 1923 convention city very serious consideration and a committee had visited the cities under consideration, voted to hold the 1923 Convention and Exposition in Pittsburgh at the Motor Square Gardens during the second week of Oct. 8 to 12 inclusive.

The selection of Pittsburgh because of its central location, and being the center of steel production of the country, and the active support and co-operation that will be given by the local chapter will meet with the most general approval of the entire membership and the exhibitors. The exposition will be held at the Motor Square Gardens and floor plans are being prepared now for distribution. The meeting rooms will be in the same building as the exposition.

FAREWELL RECEPTION TO DR. STRATTON

IN HONOR of Dr. Samuel Wesley Stratton, director of the national bureau of standards and president-elect of the Massachusetts Institute of Technology, a farewell reception was held Thursday evening, December 14, 1922, from 7:30 to 11 p. m., in the Industrial building laboratories, department of commerce, bureau of standards.

Between the hours of 7:30 to 9:00 members of the staff and their guests held a reception to Dr. Stratton. Also during these hours a trip through the laboratories of the Industrial building had been arranged. Many interesting pieces of apparatus were in operation. Notable among these were the cement testing and stone sawing apparatus; the cement kilns; the enamel furnaces; the general ceramic kilns; the glass plant where glass was being melted; the paper mill, which was in operation; the textile mill and the rubber laboratory.

At 9 p. m. all of the staff members and guests assembled in center wing of the building at which time Secretary of Commerce Herbert Hoover briefly addressed the assembly expressing his sincere regrets that Dr. Stratton was leaving the bureau. In commenting on the resignation of Dr. Stratton he said that the loss of Dr. Stratton as head of the bureau of standards is a real national loss. He has built up that service from a bureau devoted to scientific determination of weights and measurements to a great physical laboratory co-operating with American industry and commerce in the solution of many problems of enormous value in industry which the commercial laboratories of the country, from lack of equipment and personnel, have been unable to undertake. He added that every possible effort would be made to secure a successor to Dr. Stratton who would carry forward the most excellent work that has been planned and a great deal of which has been executed during the 21 years of Dr. Stratton's service.

Secretary Hoover then turned the meeting over to Dr. Holbrook, who reviewed at some length the work that had been accomplished by Dr. Stratton and the bureau of standards.

In closing, Dr. Holbrook presented Dr. Stratton with a silver tea service and table which he will take with him upon his departure from the bureau, as a token of the esteem which his staff has for him.

Dr. Stratton was considerably affected by this presentation and thanked his staff and colleagues most graciously. He then outlined in his speech, the wonderful growth of the bureau of standards. He reviewed the work of each of the departments indicating the important things which had been accomplished and those which were still under investigation, illustrating for example, the valuable data which had been obtained by engineers in the study of large railroad bridge members, in the 3,000,000-pound testing machine which was in the room in which the audience was seated. Numerous other examples were related in which the bureau had aided the advancement of civilization.

In closing, Dr. Stratton said that he would always remain in close touch with the bureau and that the bureau's interests would always be his interests.

Following the general assembly, special exhibits selected from other buildings of the bureau were on display and most of them were in operation. Coincident with this exhibit, dancing was in order on the floor below. The

United States Marine band furnished the music for this enjoyable period which ended all too soon.

WINTER SECTIONAL MEETING

The Winter sectional meeting of the A. S. S. T. will be held in the city of Chicago on Feb. 8 and 9, at the City Club. The arrangement of the program and details are in charge of the executive committee of the Chicago Chapter of which Harold Wood, metallurgist with the Wyman-Gordon Co., Ingalls-Shepard Division, Harvey, Ill. is chairman and Harry Blumberg of the Illinois Steel Co., is Secretary.

It is planned that on Thursday, Feb. 8, the afternoon and evening will be occupied by the presentation of technical papers with a dinner meeting in the evening at the City Club. On Friday the ninth there will be no papers presented, but those in attendance will be given an opportunity to visit industrial plants in Chicago and vicinity in case they care to do so.

The regular quarterly meeting of the Board of Directors will be held at the City Club on Friday.

The Chicago chapter is planning an exceptionally fine program and it is urged that all those who can possibly find the opportunity should attend.

NOMINATING COMMITTEE FOR 1923 APPOINTED

PRESIDENT T. D. Lynch of the American Society for Steel Treating has announced the appointment of a Nominating Committee for the selection of National officers for 1923 and 1924. The personnel of the committee represents five of the chapters of the Society, distributed geographically and recommended for appointment on this committee by the various chapters. The members of this committee were selected from those chapters that had not previously been represented on the Nominating Committee. The committee is as follows:

H. J. Stagg, Gen. Mgr., Halcomb Steel Co., Syracuse, N. Y. Chairman.

C. E. McQuigg, Metallurgical Engineer, Union Carbides and Carbon Research Laboratory, Inc., Thompson and Manley Sts, Long Island City, N. Y., Member.

Mr. Jerome Strauss, Metallurgist, Navy Yard, Washington, D. C., Member.

Mr. W. R. Chapin, Metallurgist, E. C. Atkins & Co., Inc., Indianapolis, Indiana, Member.

Mr. C. B. Swander, Metallurgist, Wagner Elec. & Mfg. Co, St. Louis, Mo., member.

The officers to be selected by this nominating committee are as follows:

President for one year
Second Vice-President for two years
Treasurer for two years
One member Board of Directors for two years

This committee will announce its selection of candidates for national offices in the June TRANSACTIONS. These new officers will be voted on by mail ballots sent to the members of the society and will assume office during the 1923 annual convention at Pittsburgh.

Voting members of the Society are requested to recommend to the committee, names of eligible persons for the elective offices.

RECENT RESEARCHES ON THE ELASTIC LIMIT

By Herman A. Holz

Abstract

This paper deals with a discussion of those properties of metals which are of vital importance in the design of engineering structures. It points out some of the fallacies in the use of the elastic limit, proportional limit, yield point and maximum strength in design. The practice of European engineers is briefly outlined.

The various types of machines or apparatus for determining the elastic limit, proportional limit, yield point etc., are discussed. A detailed description of the latest type extensometer as contrasted with those previously available constitutes the major portion of this paper. Numerous stress-strain diagrams taken of various ferrous and non-ferrous metals are shown.

The instrument described, operates on a principle similar to a mirror galvanometer in which the beam of light reflected by the mirror traces a path on a photographic plate. This principle eliminates the pencil friction of some of the older types of stress-strain curve plotting apparatus. The results obtained with this new type instrument permits of the study of certain peculiarities in the stress-strain diagrams of metals and alloys which were obscured in the diagrams plotted by the other earlier instruments.

General

FROM the standpoint of practical engineering and safety the *elastic limit* is undoubtedly the most important physical property of a metal. What the engineer desires to know from the metallurgist is the complete story of the behavior of metals up to their yield point. The actual breaking strength of metals is of much less importance.

A material is elastic with regard to any applied stress if a strain (the change of shape produced by stress) disappears when the stress is removed. Strain which persists after the stress that produced it is removed is called permanent set. Most metals are perfectly elastic with regard to small stresses and very imperfectly elastic with regard to great stresses. In general, within certain limits the strain produced in metals is small in amount and disappears entirely when the stress is removed. If the applied stress exceeds this limit, the strain is much greater than before and when the stress is removed most of it is found to consist of permanent set.

The maximum load, expressed in pounds per square inch or equivalent units, which can be applied without causing a permanent set is called the elastic limit of the material. Engineers in some European countries use as a specification for elastic limit, that load which is required to cause a permanent set of .02 per cent on a 20 centimeter specimen, using an extensometer reading to one ten thousandths millimeters. This limit has been established because in practice it has been difficult to determine the actual maximum load which can be applied without causing any permanent set whatever. This difficulty is quite similar to the one encountered in research work on the

---

A paper presented before the annual convention of the Society, September, 1921.
The author, Herman A. Holz, is president of Holz & Co., Inc., New York City.

hardness of metals, where it would be desirable to put a load on a ball which would just fail to produce any indentation in the material under test, however, due to mechanical difficulties this method of test has not been perfected.

Hooke's Law

According to Hooke's law enunciated by him in 1676, the strain produced by a stress within the limits of elasticity of a material is directly proportional to the stress producing it. In applying Hooke's law to the case of simple longitudinal stress, such as the case of a bar stretched by simple longitudinal pull, we can measure the state of strain by the change of length per unit of original length which the bar undergoes when stressed. Let the original length be l and let the whole change of length be cl when a stress is applied whose intensity s is within the elastic limit or the limit of proportionality. Then the strain is measured by cl/l and this by Hooke's law is proportional to s. This may be written

$$\frac{cl}{l} = \frac{s}{E}$$

where E is a constant for the particular material under investigation. Theoretically, the same value of E applies to compression and pull, inasmuch as both forms of stress are essentially continuous, differing only in sign. The constant E is called the modulus of longitudinal extensibility or Young's modulus. It is frequently called the modulus of elasticity, although this term is too general. There has not been a full systematic investigation undertaken regarding the temperature variations of these elastic conditions, but it has been established that there is a relation between the rate at which the elastic properties of metals change with temperature and their melting point.

Determination of the Elastic Limit Important

Returning to the practical conclusions which can be drawn from these theoretical facts, we must realize that in applying a knowledge of the behavior of metals to determine the proper sizes of parts in any engineering structure it is necessary to estimate a permissible working stress. It is the elastic limit rather than the maximum strength of material which determines the magnitude of the working stress that may be permitted with safety under any particular conditions of loading. Accordingly it becomes a matter of utmost practical importance to determine by careful tests the amount of stress which the material will stand without permanent strain, that is, we must determine the elastic limit.

Various Instruments Available
Martens Extensometer

Although the importance of the accurate determination of the elastic limit has been recognized by most research workers, the test has not become a routine test and has not been regularly carried out in American works practice, because the apparatus available in the past for real precise determinations have been rather complicated, being designed mainly for research work. The most reliable apparatus for accurate determinations of the elastic limit is the well known mirror extensometer designed by Martens,

which measures extensions to one ten thousandths of a millimeter. This apparatus, however, is capable of measuring only very small variations in length and requires considerable care and skill on part of the operator. The Martens mirror extensometer, as made by Amsler in Switzerland, is shown in Fig. 1 and 2, while the principle can be seen in the diagram Fig. 3.

Fig. 1 shows the standard instrument attached to a tensile specimen. Fig. 2 shows the apparatus with specially designed long mirror carriers applied

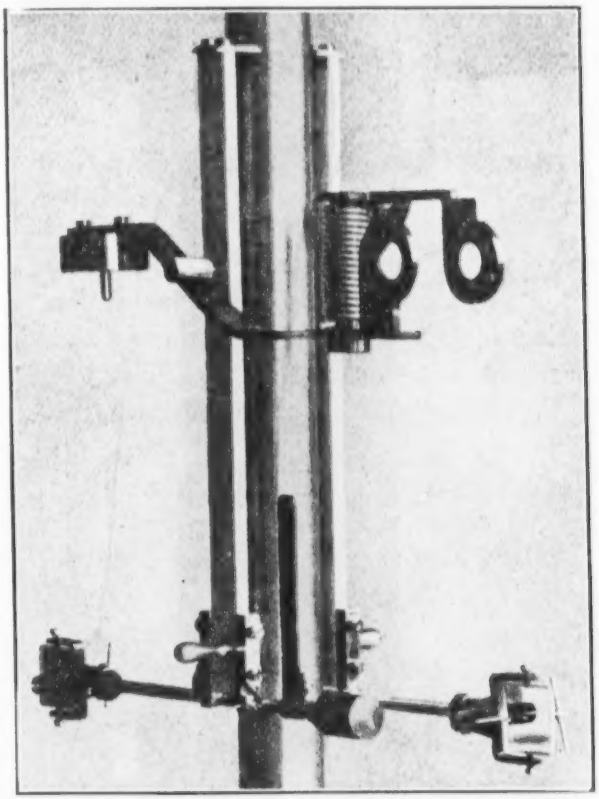


Fig. 1—Martens Mirror Extensometer Attached to Tensile Specimen

to a cylinder which is used for checking the calibration of test presses up to 1,000,000 pounds. Fig. 4 shows Amsler's observation apparatus consisting of telescopes, measuring scales and tripod, all mounted in such manner that each element can be adjusted separately in a horizontal and tilted position. This instrument operates in a manner similar to a reflecting mirror galvanometer. A detailed explanation of the formulas used in the calculations of results obtained with this instrument is unnecessary.

It may be of interest to note that a Martens mirror extensometer has recently been constructed and successfully used for research work on specimens heated up to 850 degrees Cent. In this modified apparatus, the general design was kept the same, but various parts exposed to high temperatures had to be made of special materials. It will be readily understood that since many of our steels, especially in essential parts of internal combustion engines, of boilers and many other pieces of apparatus and equipment, as well as many of our cutting tools are used at high temperatures, therefore, investigations of the elastic limit, hardness and other physical properties at elevated temperatures are of great practical importance.

Ewing Extensometer

Sir J. A. Ewing has designed a self contained microscope extensometer which is more convenient but not quite as accurate as the Martens mirror apparatus. In this apparatus, diagrammatically shown in Fig. 5, the exten-

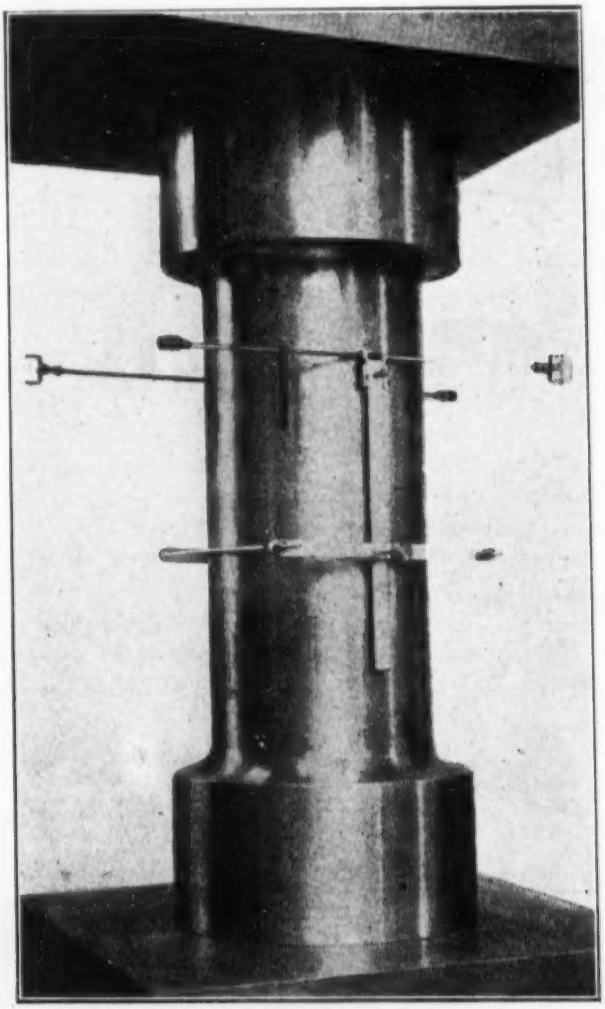


Fig. 2—Martens Mirror Extensometer With Long Mirror Carriers for Compression Tests

sion of specimen *A* is magnified by a system of levers *B'*, *C* and *Q* to a freely suspended rod R carrying a mark at its lower end, on which a reading miscroscope is sighted, carrying a micrometer scale in its eyepiece.

Dalby Extensometer

The greatest disadvantage of all such extensometers for practical work is that they require the closest attention of at least one operator, that they take up considerable time and that they are not autographic; the observations are taken at definite points, not continuously, and have to be plotted afterwards. These difficulties have recently been overcome by Professor Dalby of London who has designed an autographic optical load-elastic extension recorder which combines the features of great accuracy, speed, robust construction and complete elimination of the personal element. This apparatus

opens up a large field of possibilities for original research on the correlation of the true elastic limit with other physical properties such as fatigue resistance, notch-brittleness, ductility, etc., and makes it possible for the first time, to include accurate determinations of the elastic limit in routine tests. From the records obtained the true elastic properties of metals can be immediately deduced; the autographic curve produced by this ingenious apparatus, showing at a glance the limit of proportionality, furnishes data from which some new elastic constants can be studied.

This optical recorder, like all other scientific apparatus, went through several stages of evolution until it finally reached the stage of its highest development as shown in Fig. 6. In Fig. 7 the instrument is shown, set up in a specially designed testing machine. In Fig. 6, *W* is a bar of steel about one foot long, which is called the *weigh-bar*, while *F* is the specimen under test. The weigh-bar is attached at one end to the testing machine, while its other end is coupled to the test specimen, the lower end of the specimen being connected to the grip at the base of the testing machine. The weigh-bar

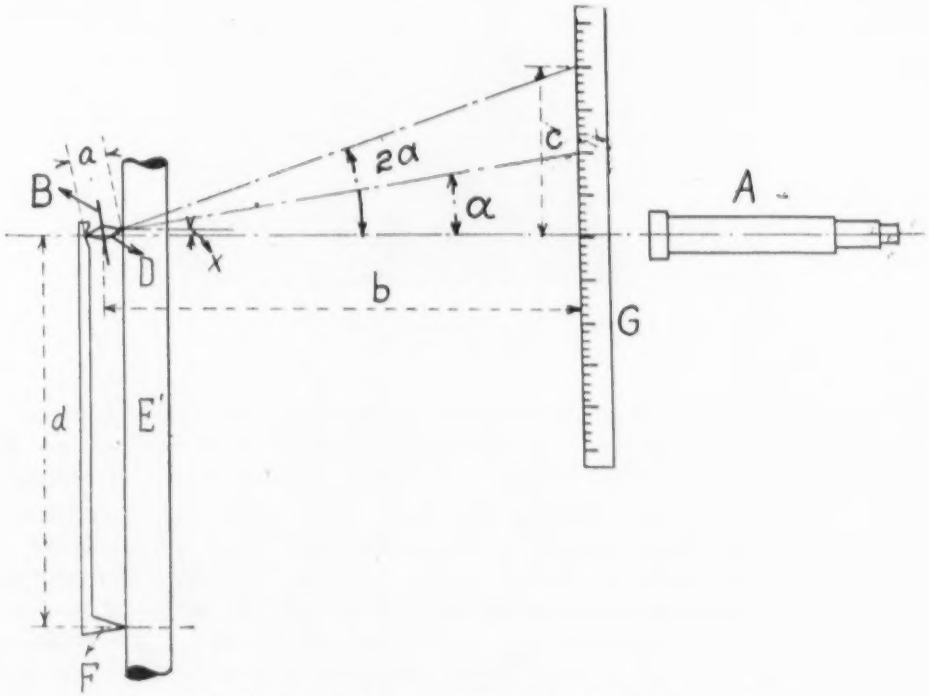


Fig. 3—Diagram Showing the Principle of the Martens Mirror Extensometer

and the specimen bar are then like two links of a chain stretched between the shackles of a testing machine, so that the pull applied by the machine is applied equally to both bars. The cross sections of the bars are proportioned in such manner that the pull applied through them is ultimately able to break the specimen bar without loading the weigh-bar beyond its elastic limit. The stretch of the weigh-bar is used to determine the load passing equally through it and the specimen. The apparatus is autographic, as a record of the load applied and the extension of the specimen is made by the movement of a spot of light over a photographic plate held in a camera attached to the weigh-bar. If the spot of light is focused on the ground glass of the camera, an increase of load moves the spot vertically and proportionally to the increase of gage length, but horizontally and proportionally to the extension of

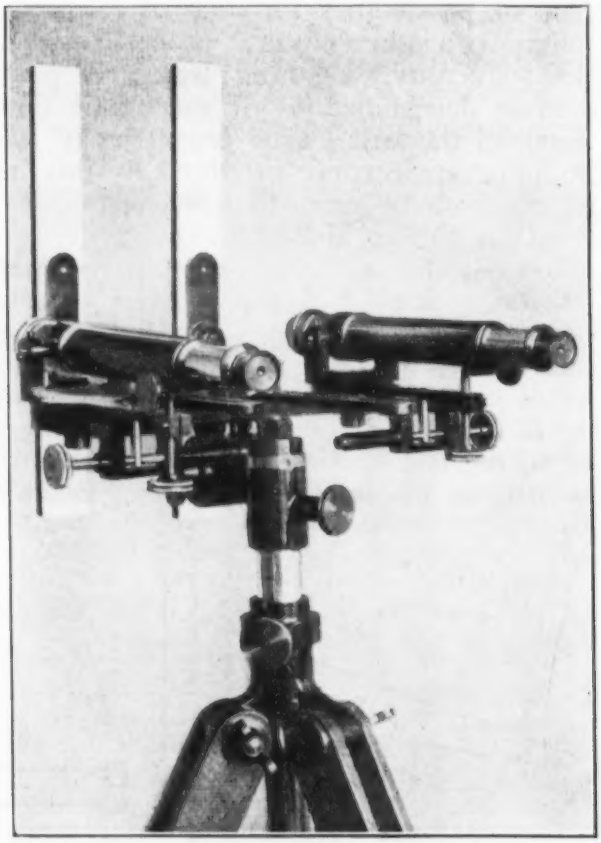


Fig. 4—Observation Apparatus for Martens Extensometer

the weigh-bar and therefore proportionally to the load on the test piece. This effect is produced by a system of suitably arranged mirrors and an electric incandescent lamp which is the source of light. Convenient adjustments are provided at *H* and *P* for setting the load zero and the extension zero. The extension of the gage length is transmitted to the optical lever within the weigh-bar by the chain of levers partly seen in Fig. 6. The microscope *R* is added for convenience, so that the extension may be watched as the piece stretches. An index is secured to one of the moving parts of the transmission gear, and when the microscope is properly focused and adjusted, this index is seen moving across a scale in the eyepiece. This enables the load to be stopped at any desired stretch. The load may then be removed and re-applied and varied as desired, because the effect of each variation is clearly seen in the field of the microscope. Watching the movement of the index in the field of the microscope is equivalent to watching the vertical movement of the spot of light over the camera plate on which it is focused. Regulation of the brilliancy of the light is effected by a special switch box seen in Fig. 7 at the base of the testing machine. An interrupter can be inserted into the circuit so that the light can be interrupted at definite intervals, for example every 1/10 or 1/20 second. This produces curves consisting of dashes and permits accurate time investigations of the various phenomena shown in the curves. Accurate curves have been taken within 2 seconds from zero to break, with the time occupied to the yield point of ½ second.

The absence of pencil friction in the diagrams brings out irregularities in the curve drawn that are due only to the behavior of the metal itself. In

the old style tensile machines, the friction from pencil and mechanism produces irregularities in such curves which prevent the true relation between load and extension from being accurately shown. In the photographic diagrams, the continuously changing relation between the change of load and the change of length can be seen directly from the curve, and the changing shapes of the curves reveal, by comparison, qualities of the materials which are essential to know. The advantages of possessing accurate load-extension diagrams may be briefly summarized: differences in quality are shown at a glance by merely comparing the shapes of the curves, and material delivered at any one time may thus be critically compared in quality with similar material delivered at any other time, presuming, of course, that the diagrams are taken from test pieces of identical dimensions. In particular, overstrained steel is immediately detected, because its load-extension curve differs markedly in shape from that taken from normal material. The tensile test, as ordinarily carried out, tells a very small part of the story which it can be made to tell if carried out by such refined apparatus, that is, apparatus which completely eliminates friction and inertia from the recording mechanism. Fig. 8 shows as much of a load-extension diagram as can be plotted from

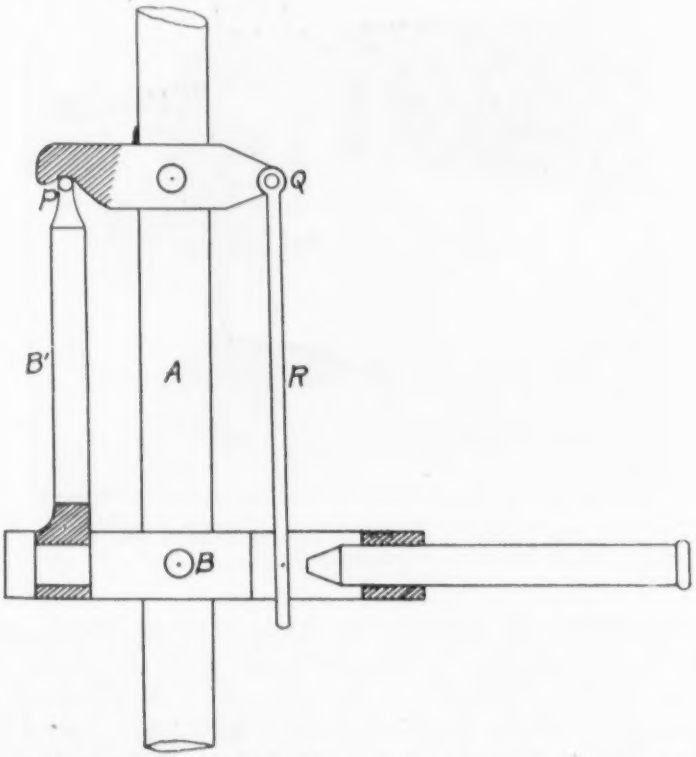


Fig. 5—Diagrammatic View of the Ewing Extensometer

the data of an ordinary tensile test. The data give yield-load with no corresponding extension, maximum load with no corresponding extension, maximum extension with no corresponding load. From these data it is impossible to plot a single point. We have at our disposal:

1. The ordinate of yield but not the abscissa
2. The ordinate of maximum load but not the abscissa
3. The abscissa at fracture but not the ordinate of load

From these considerations it will be evident why many defects in the quality of metals remained undiscovered in the ordinary tensile test.

Stress-Strain Curves Plotted by Optical Extensometer

We will now proceed to show the results of refined tensile tests which, instead of the half coordinates of three points, record a continuous curve which corresponds to complete coordinates an an infinite number of points. Fig. 9 is a correct load-extension curve of a piece of Yorkshire iron of quality *A*, while Fig. 10 shows the corresponding curve for Yorkshire iron of

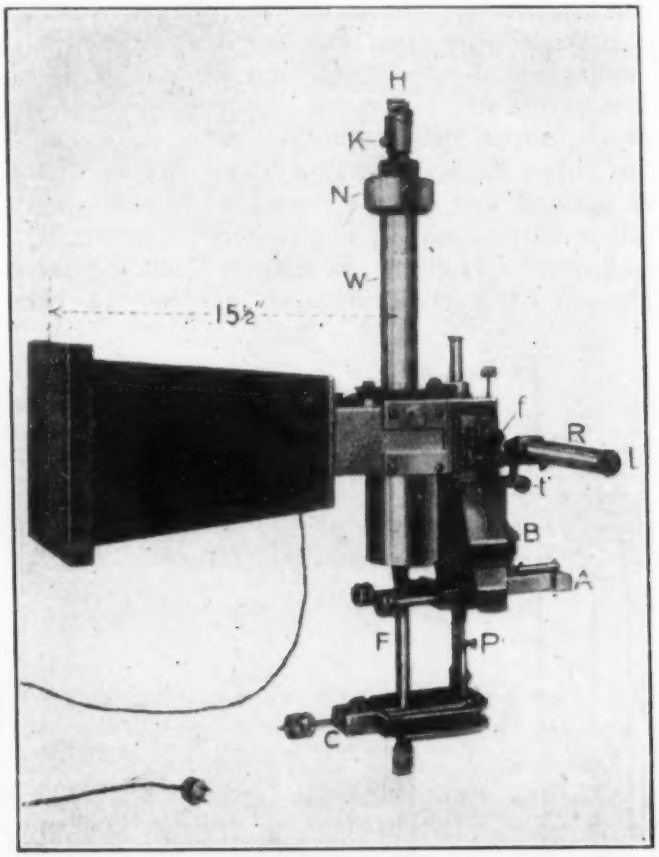


Fig. 6—The Dalby Autographic Optical Load-Elastic Extension Recorder

quality *B;* the diagrams are continuous from zero to break, and their shape is characteristic of the quality of this particular type of iron. Fig. 11 shows a curve taken on Staffordshire iron, and Fig. 12 one taken on Swedish iron. Fig. 13 shows a curve taken on electrolytic copper and Fig. 14 one taken on arsenical copper. While changes in the process of manufacture and treatment are clearly shown in changes in the shape of the iron curves, although they may not materially influence the yield-point, maximum load, and total extension, the contrast between the iron curves and copper curves is so great that they may be readily distinguished and classified. The curves of brass, phosphor bronze, aluminum, zinc, tin, etc., are all truly characteristic and easily distinguished.

Fig. 15 and 16 are the curves of mild steel .12 carbon and .22 carbon, while Fig. 17 and 18 are taken on carbon steels .42 carbon and .56 carbon.

As will be seen, the load-extension curves of iron and carbon steel are not continuous from zero to break, but show a discontinuity between the elastic

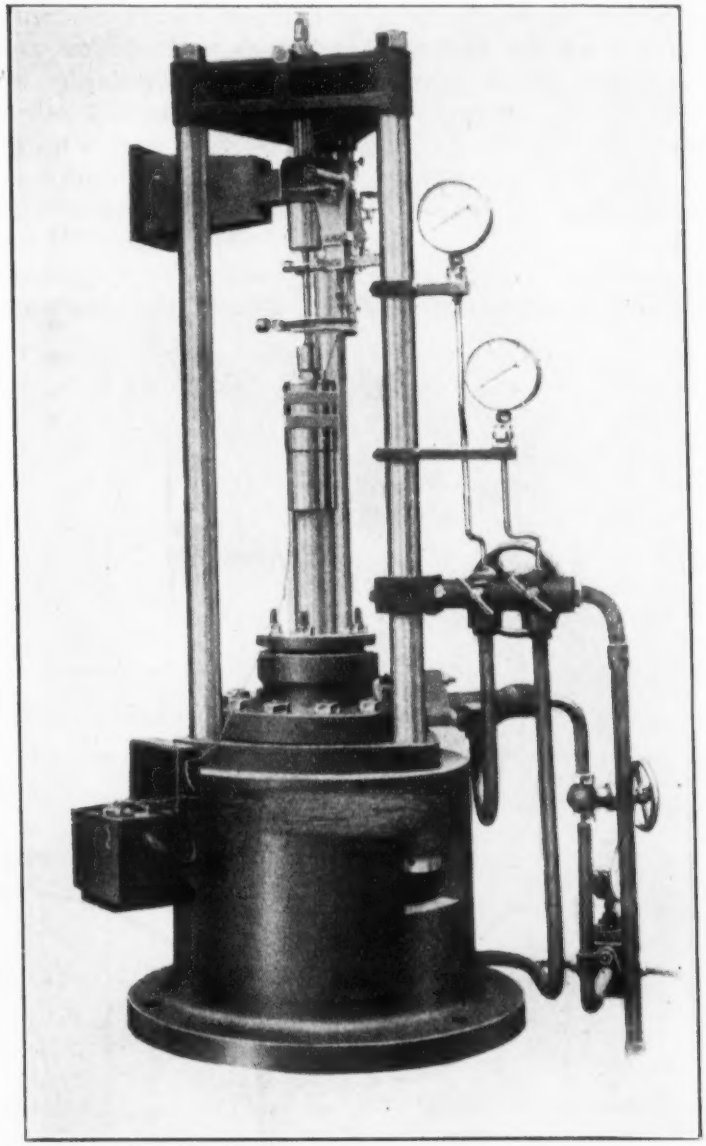


Fig. 7—Dalby Apparatus Mounted on Special Hydraulic Tensile Testing Machine

part which appears almost vertical in the diagrams, and the plastic part. The two parts are joined by a link, irregular in shape and suggesting that the passage from the elastic to the plastic state in these metals is not made without some profound molecular disturbance. It is an unsolved problem why iron and plain carbon steel should always show this link when in normal condition, while no other metal or alloy gives the slightest indication of it but changes smoothly from the elastic to the plastic state.

Speaking of these curves in general, it can be stated that any change in composition or treatment is shown in a slight change in the shape of the curve; however, the group characteristics of the curves for the particular metal on which the curve was taken is retained. A systematic recording of load-extension curves of material in routine testing practice would certainly be valuable, as any changes in composition and treatment are shown up in a manner which is unmistakable, if experience in the interpretation of the curve differences has been gained.

The character of the curves change as soon as any element is alloyed with steel. Notwithstanding the fact that carbon is still present, in alloy steels the change from the elastic to the plastic state is done smoothly, as will be seen in Fig. 19 (nickel-chrome steel, C .33, Mn .33, Ni 3.74, Cr 1.73). Fig. 20 (Hadfield's manganese steel C 1.26, Mn 11.75) and Fig. 21 (high nickel steel). In the Hadfield manganese steel, the plastic curve is replaced by a stepped curve and there is no local contraction. The bar extends uniformly and then breaks.

This new apparatus has also made it possible to investigate very carefully and conveniently the influence of the length of the specimens, shoulders of

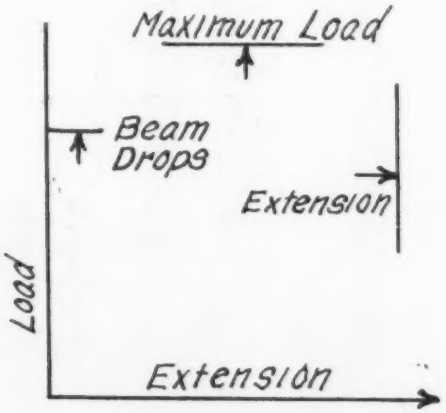


Fig. 8—Diagrammatic Sketch of Data Given by the Ordinary Tensile Test

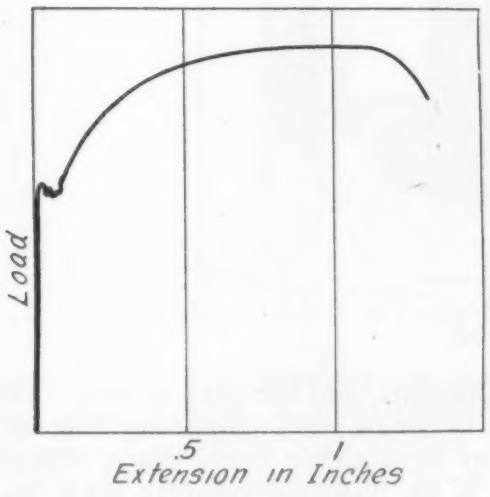


Fig. 9—Optical Load-Extension Curve Taken from Yorkshire Iron—Quality A. Extension on 5 Inches

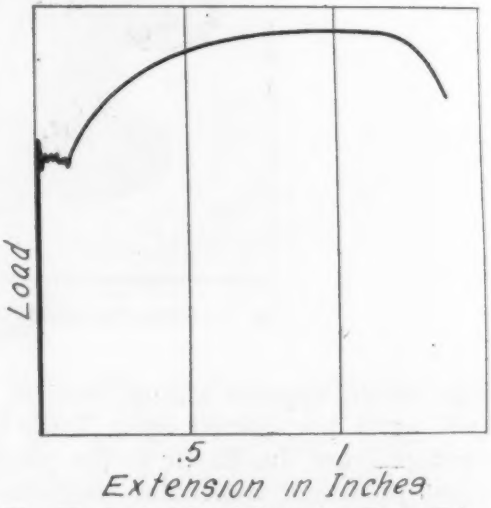


Fig. 10—Optical Load-Extension Curve Taken from Yorkshire Iron—Quality B. Extension on 5 Inches

the specimens, gage length on the extension, contraction of area, and also the influence of speed of testing on the final results. Several short specimens were broken in 1 second, obtaining during this second a complete load-extension diagram.

In the most recent researches undertaken, a special type of specimen was developed which was found to give most reliable results. In this specimen, shown in Fig. 22, the gage length is defined by flanges turned on the test piece itself. The ends of the arms of the extensometer rest on these flanges.

A gage length of 5 inches is used on iron and steels, while shorter specimens are used on the more ductile metals. The main reason for developing this flanged specimen was the difficulty encountered when pointed screws were to be driven into the specimens to define the gage length. The screws cannot be properly driven into hard materials like alloy steels, and in soft metals the

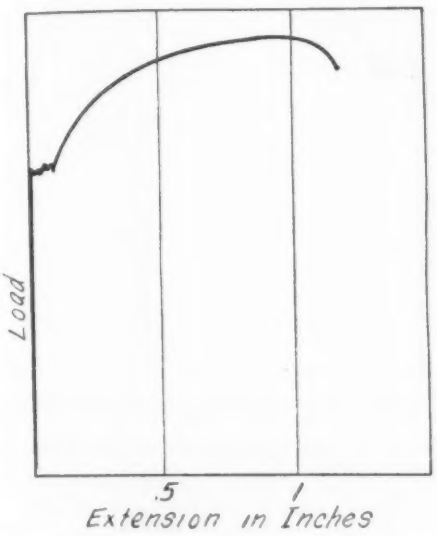


Fig. 11—Optical Load-Extension Curve Taken on Staffordshire Iron. Extension on 5 Inches

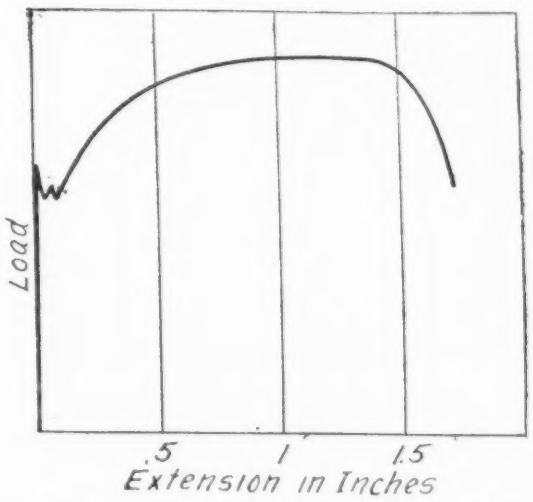


Fig. 12—Optical Load-Extension Curve Taken on Swedish Iron. Extension on 5 Inches

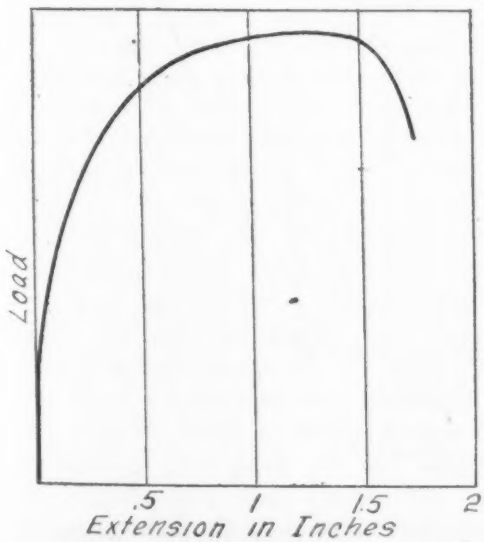


Fig. 13—Optical Load-Extension Curve Taken on Electrolytic Copper. Extension on 3 Inches

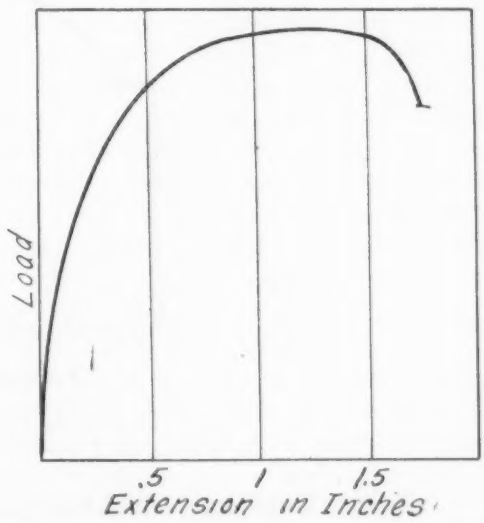


Fig. 14—Optical Load-Extension Curve Taken on Arsenical Copper. Extension on 3 Inches

center punch dot elongates during stretching and the gage points slip. The modulus of elasticity found from the flanged test pieces agrees with that found on plain bars. The flanges therefore have no influence on the elastic extension of the gage length, while they restrict the plastic extension very slightly. Professor Coker has investigated the distribution of stress produced by these flanges, by means of his well known method utilizing polarized light for studying stress distributions and found no stresses in the flanges them-

selves, but a slight and symmetrical modification of stress distribution at their roots. This means that as stretching proceeds the flanges are not distorted, and therefore the distance between the flanges is a true measure of the extension of the gage length which they define.

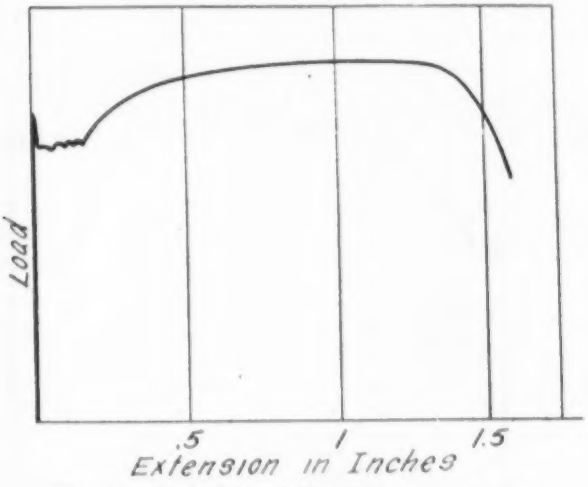


Fig. 15—Optical Load-Extension Curve Taken on Mild Steel. Carbon .12. Extension on 5 Inches

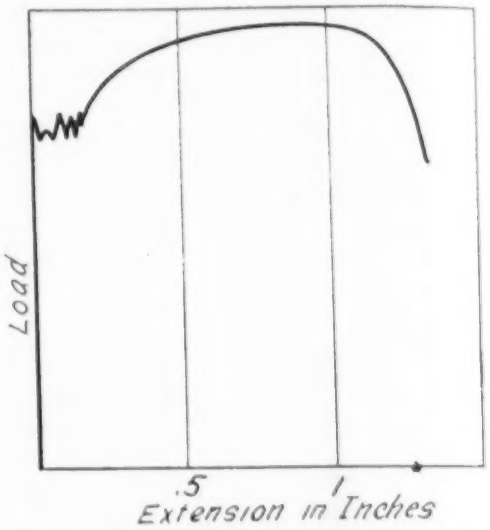


Fig. 16—Optical Load-Extension Curve Taken on Mild Steel. Carbon .22. Extension on 5 Inches

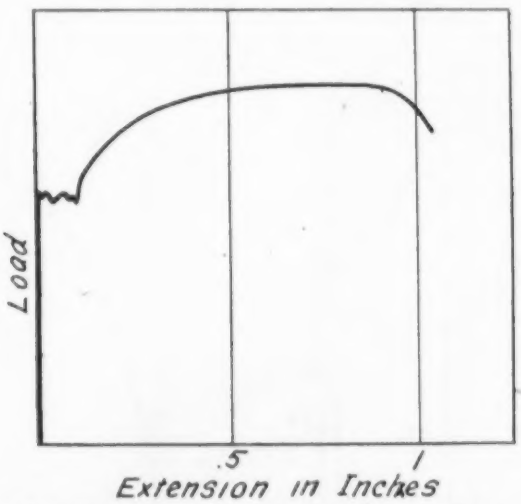


Fig. 17—Optical Load-Extension Curve Taken on Medium Carbon Steel. Carbon .42. Extension on 5 Inches

It has been seen that the power of complete recovery is lost when the stress produced by loading has once passed beyond a certain limiting value peculiar to the material. Below this limiting stress the extension of a steel specimen is proportional to the load producing it. Above this limiting stress the extension increases at a greater rate than the load. This limit is, therefore, called the limit of proportionality, but the term elastic limit is often used to define this point. The use of this term would seem to convey that the elastic power of the material is exhausted when once the stress has passed beyond the elastic limit and the material has passed into a plastic state. This is not true. The material possesses elastic properties right up to the instance of fracture.

If a specimen loaded nearly to the point of fracture is investigated in the testing machine, and the load quickly removed, the specimen will spring back. Precise measurements, however, will show that the relation between stress

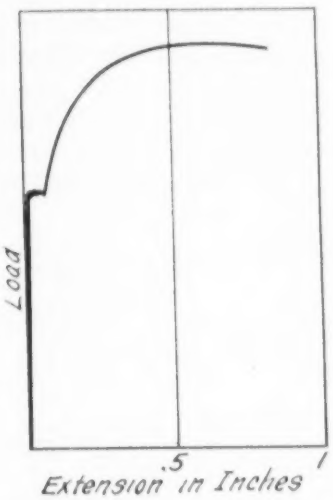


Fig. 18—Optical Load-Extension Curve Taken on Medium Carbon Steel. Carbon .56. Extension on 5 Inches

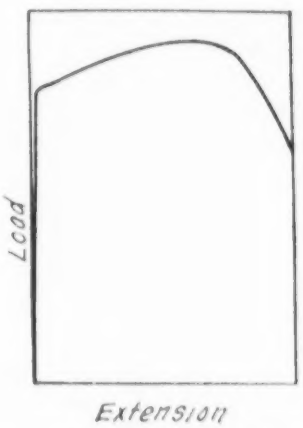


Fig. 19—Optical Load-Extension Curve Taken on Nickel-Chromium Steel. Extension on 5 Inches

and strain is then unproportional. The specimen fails to return to its original dimension by the amount of the permanent set. Professor Dalby uses the term unproportional elasticity to describe the state of the material under these circumstances.

If the loading on the specimen is stopped at any point after the elastic limit has been passed and then removed and afterward re-applied, the process involves the doing of work on the inner structure of the material and the record produced by the optical extensometer is a loop, the area of which represents the work done. Since the recorder is fitted with an observation microscope, the process of stretching and partial recovery can be conveniently watched as the experiment proceeds, and since the testing machine used is hydraulic, the load can be conveniently and rapidly released and reapplied.

Fig. 23 shows a looped diagram thus obtained on a specimen of nickel steel. It will be readily understood that the removal and reapplication of the load compels the spot of light to trace a loop. The area of the loop shows the kind of action that went on in the metal when it was stretched beyond the elastic limit and represents the internal work done during the process. Following the path of the spot it starts from the origin O and describes the elastic line OA, passes the limit of proportionality at A, and then curves away to the yield point B, and on to C. At C the loading is stopped, the hydraulic pressure is released by opening the exhaust valve, and the spot travels down the curved path CD as the load falls to zero. The exhaust valve is then closed, the pressure valve is opened, and the process is repeated through the path EF and so on. When the specimen has been stretched beyond its limit of proportionality, for instance to C in Fig. 23, the total extension is made up of two parts, namely:

1. The proportional elastic extension up to the limit of elasticity, for example up to A, in Fig. 23
2. The plastic extension after the limit has been passed

When the load is removed the steel shrinks unproportionally, for example

from C to D, by an amount approximately equal to its previous proportional elastic extension and then stops at a dimension greater than its original dimension by an amount approximately equal to its plastic extension. The increase of size measured after removal of the load is the permanent set: OD is the permanent set produced by the first stretching of the specimen to C. From the diagram this permanent set measures .0052 inch and the unproportional elastic recovery measures .011 inches. When the load is reapplied, the spot of light moves from D to E along a curved path. The extension is no longer proportional to the load. The metal is still in an elastic state, but of different nature. Stretching beyond the limit of proportionality has robbed

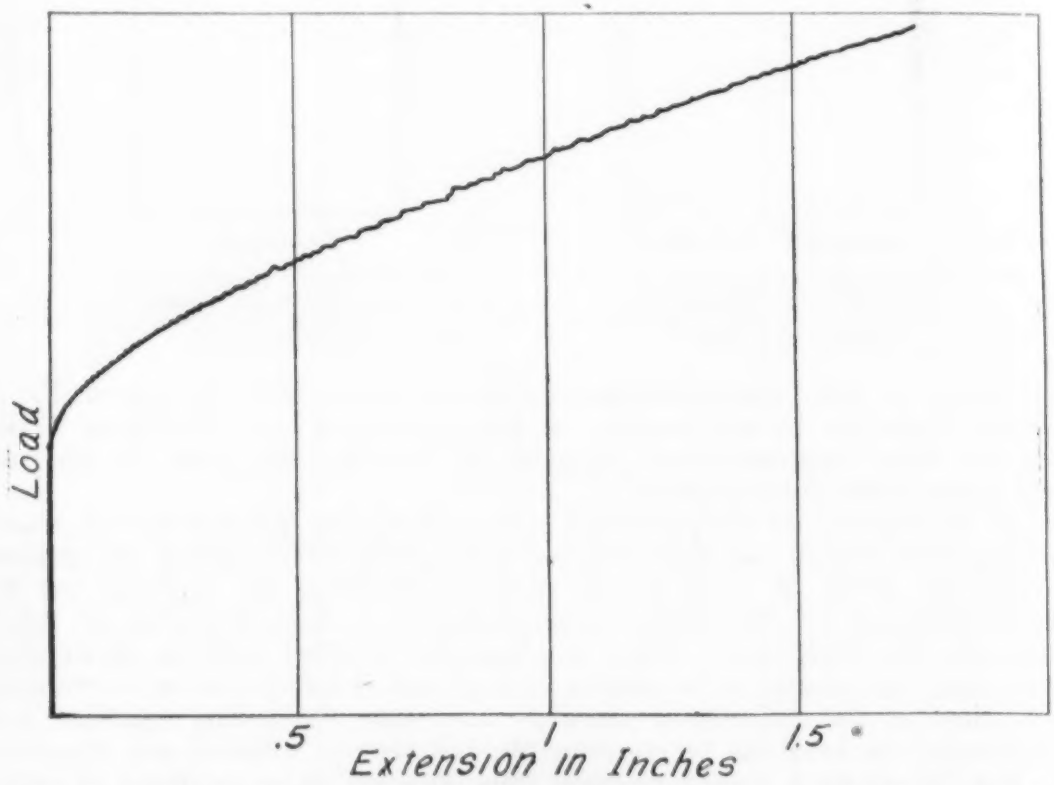


Fig. 20—Optical Load-Extension Curve Taken on Hadfield Manganese Steel. The Plastic Curve is Replaced by a Stepped Curve and There is no Local Contraction. Extension on 4 Inches.

the metal of its power of proportional extension and of perfect recovery after the removal of the load. The metal may be said to be in a state of imperfect elasticity or in a state of unproportional elasticity. The imperfect state is disclosed by the loop formed upon removal and reapplication of the load. The diagram in Fig. 23 shows four loops; each loop is slightly larger than the loop preceding it. Unproportional elastic shrinkage occurs in this metal right up to the load at which local contraction begins.

Some additional records of looped diagrams are shown in the following figures, and it will be seen that looping under applied, released, and reapplied loads is a distinctive property of each metal and alloy. The load scale was varied to bring out the shape of the loops. In the original photos, 1½ inches measured horizontally on the diagrams represented 1/100 inch extension of gage length. Figs. 24 and 25 are each .80 carbon steel, both specimens supposed to be material of identical quality and composition, but taken from different deliveries. While the general appearances of both diagrams is very

similar and shows that the specimens belong to the same family, they show clearly a difference in quality. On the first specimen, the limit of proportionality is reached at 8 tons of load, and the yield at 8.85 tons. There is a slight drop at the yield load. The areas of the loops are large and increase rapidly on successive tests. On the second specimen, the limit of proportionality ends at 3 tons of load and there is no definite yield point. The loop areas and their

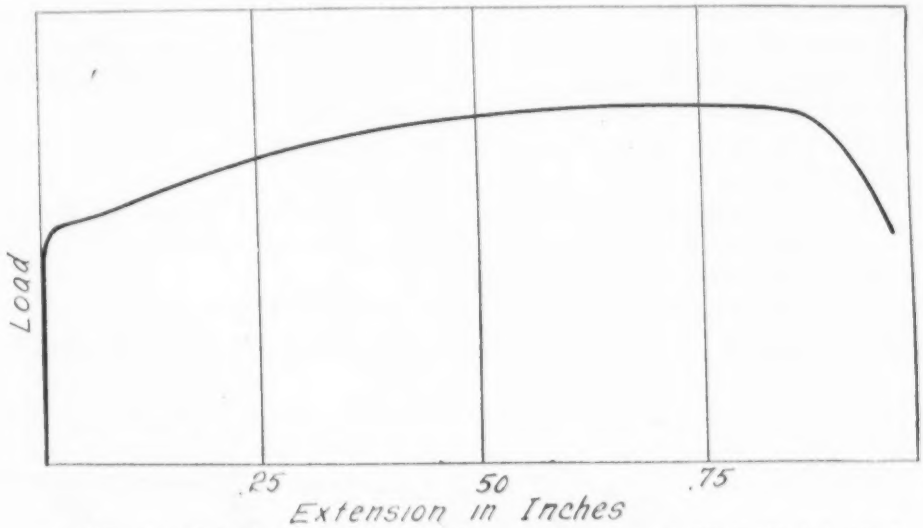


Fig. 21—Optical Load-Extension Curve Taken on a High Nickel Steel. Extension on 3 Inches

rates of increase are about equal in both diagrams. Another specimen investigated was a nickel chrome steel. The looped diagram is shown in Fig. 26. The ultimate strength of this material was found to be 54 tons per square inch, 14 per cent extension, 55 per cent reduction of area. The limit of proportionality was reached at 10 tons of load on a .625-inch specimen, corresponding to 32.5 tons per square inch. Yield sets in at 11 tons of load or 36

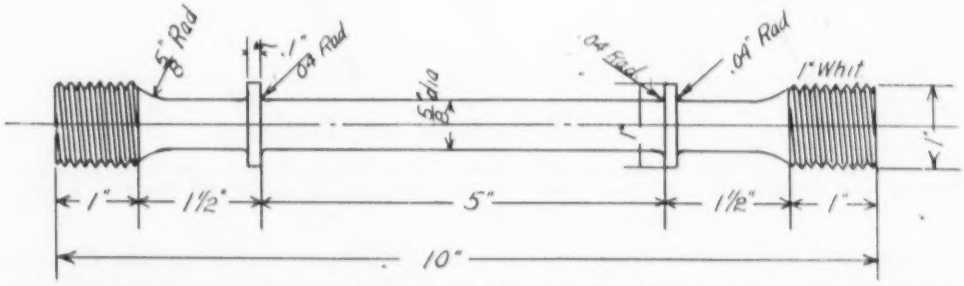


Fig. 22—Shows the New Type of Tensile Test Specimen Used in Connection with the Dalby Instrument.

tons per square inch. The first loop is small, but the areas of the loops increase quite rapidly, as seen in the 3 loops visible in the record. Very interesting loops have been obtained on zinc, tin, various coppers, brasses, phosphor bronze and aluminum alloys. The apparatus is designed in such way that the diagrams can be accurately and conveniently calibrated, and from such calibrated diagrams it is quite simple to calculate the area of the loops, the work done in elastic hysteresis, expressed in foot pounds per cubic inch of gage length, the modulus of elasticity, the stresses at the limit of proportionality and the stress at yield.

A general law has been found that the rate of increase of loop area decreases as the stretching proceeds and that the loop area tends to a limiting value. The few scattered observations shown in this paper are taken, more or less at random, from an enormous amount of research work done by Professor Dalby with this apparatus and show the possibilities of research opened up by this ingenious instrument. Systematic study of the looped diagrams, the loop areas and their rate of increase may well be expected to throw light on some of the properties of metals that are still hidden in obscurity; as this field is practically unexplored. At the same time, the data obtained will be of great practical importance and utility in industrial applications. The data that can at once be determined from the diagrams are:

1. The load at the limit of proportionality
2. The yield load
3. The modulus of elasticity (E) which is given by the slope of the elastic line
4. The work lost per loop
5. The rate of increase of the work lost per loop

The curve obtained from normal material satisfying known conditions of

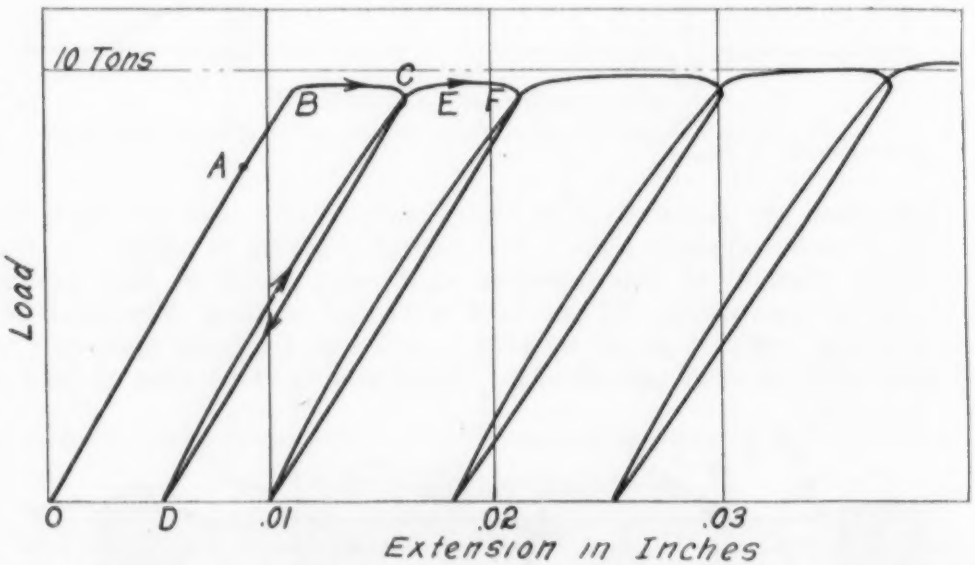


Fig. 23—Shows an Optical Load-Extension Loop Curve Obtained on a Specimen of Nickel Steel. The Removal and Reapplication of the Load Compels the Spot of Light to Trace a Loop.

composition and treatment may be used as a comparison diagram or standard. The form of the curve, the loop area and the rate of its increase, are very sensitive to small variations in the same kind of material, that is, to changes in the inner state of a metal. The diagram is especially useful in showing the load at the limit of proportionality, for this load bears neither a constant relation to the yield point, when there is one, nor to the ultimate strength. Consequently factors of safety calculated against either the yield load or the ultimate strength are ambiguous. This point is, for instance, of great importance in gun design, where the whole theory rests upon the elastic theory of the material and ceases to apply after the limit of proportionality is passed. Another important advantage of this method of investigation for practical work lies in the unification and co-ordination of existing tests which it permits.

Optical Extensometer Valuable in Routine and Research Work

It is difficult to predict whether this autographic extensometer will be of more value in routine tests or in systematic research work. It is safe to predict, however, that this apparatus will lead to some very valuable discoveries and important advances in metallurgical science. Just to mention one instance: it has been repeatedly shown during recent years that the various determinations made in conjunction with tensile tests at times fail to reveal

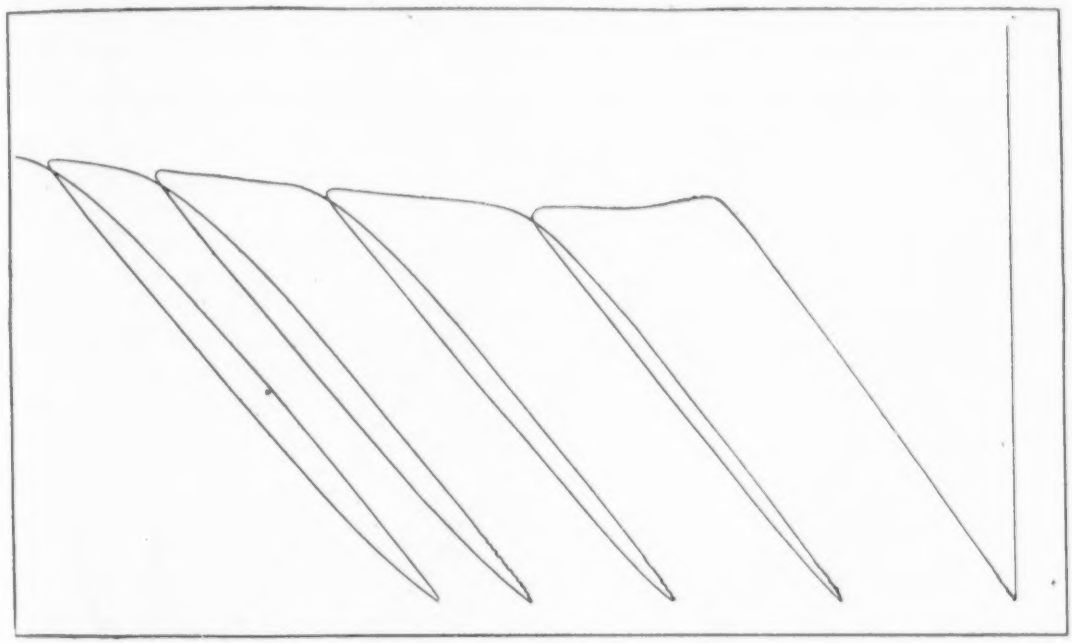


Fig. 24—Looped Optical Load-Extension Curves Taken on .80 Carbon Steel. The Load Scale was Varied to Bring Out the Shape of the Loop.

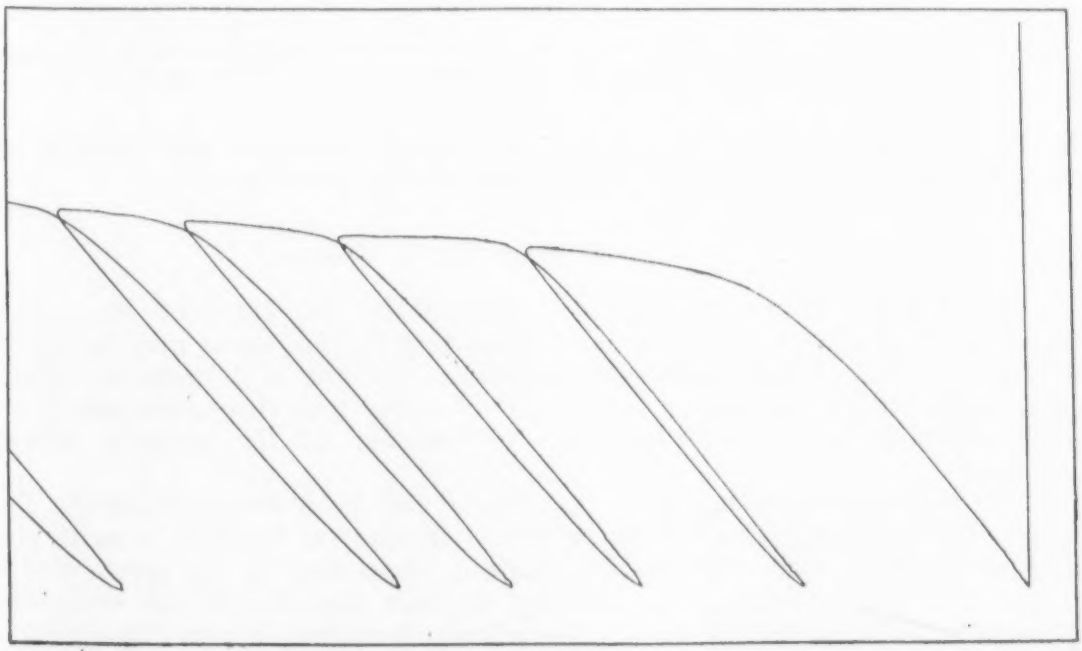


Fig. 25—Looped Optical Load-Extension Curve Taken on a .80 Carbon Steel. This Curve was Taken in the Same Manner as that of Fig. 24. The Steel was from Another Shipment.

differences brought out by notched-bar tests. This applies particularly to the so-called temper brittleness in certain alloy steels. There are instances where steels of the same hardness give widely differing values under the static and kinetic notched-bar test, and in many of these cases the tensile test and the microscope have utterly failed to give any indication of differences present in the material. This situation is now, however, remedied, because while the notched-bar tests bring out differences of quality which the ordinary tensile tests often did not reveal, the refined tensile test as carried out by means of this apparatus will show distinct differences between materials of different notched-bar values. With experience and standard diagrams as reference,

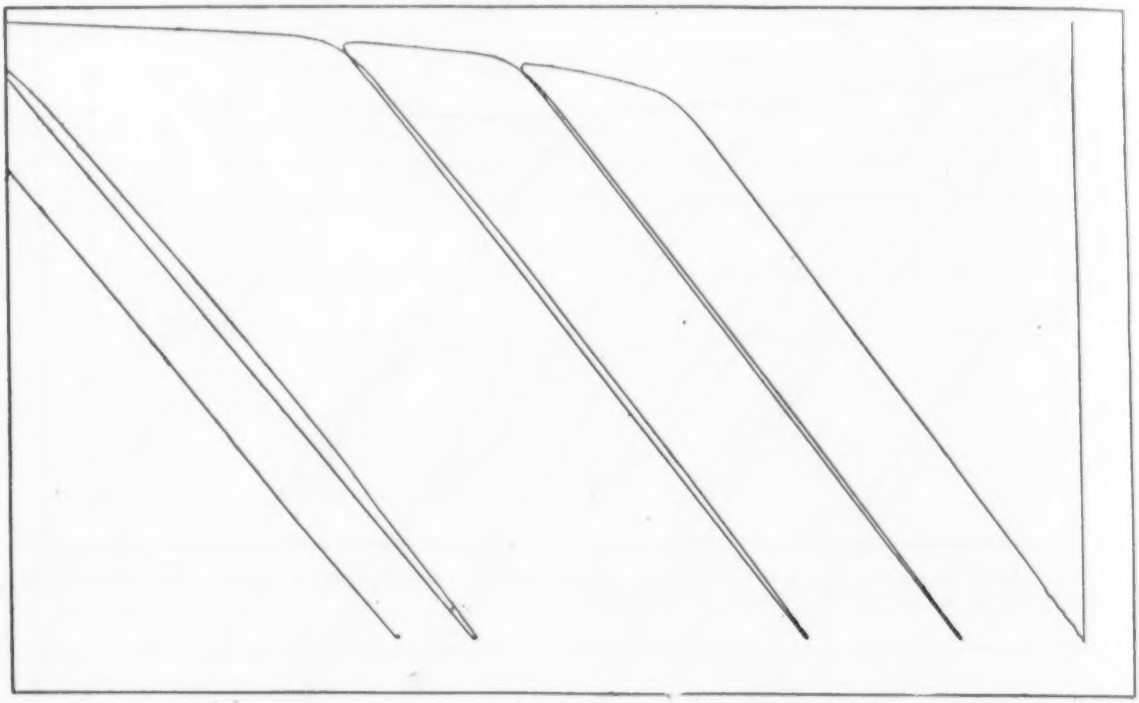


Fig. 26—Looped Optical Load-Extension Curve Taken on a Nickel-Chromium Steel

the optical load-extension curve and the looped diagrams will furnish all the information required about this quality of the material.

Overstrained Material Easily Detected

Overstrained material is at once detected by the slope of the curve. Furthermore, it is very probable that the limiting fatigue stress may be found by study of these elastic extension diagrams. Fatigue is a property of the metal while within the elastic range, and it seems that this apparatus lends itself admirably to investigations of the behavior of the material within that range.

The importance of such tests of material has been demonstrated by the recent disaster of the ZR 2. According to reports on hand at present, the accident happened while the dirigible made a sharp turn at top speed, under normal atmospheric conditions. We can presume that the British engineers designed and constructed the airship on a basis of correct figures for ultimate stress and elastic limit. But the huge frame was made of an alloy of which less is known of its mechanical properties than is known of steel. The vibra-

tions to which the framework was exposed at top speed of the various motors must have been enormous, and the detrimental influence of these vibrations combined with the enormous strain caused by a sharp turn, seem to have been the cause of the terrible disaster.

It is probable that in steel the limiting range of stress in fatigue has for its positive value the stress equal to the limit of proportionality. A series of specimens has already been investigated for this correlation and the results obtained show very close agreement. If it can be shown by further research work that these results can be generalized, it could be asserted that the load-extension curve shows the positive value of the fatigue limit. Extended investigations in this direction, over a wide range of materials, are also a promising field of research.

The limit of proportionality and other elastic constants can be determined automatically with this recorder and so quickly that there is now no reason why these important figures should not be included in the routine tests of metals.

Full credit is due to Professor Dalby for the excellent research work done in the development of this apparatus and its application to the increased knowledge of the elastic conditions of metals. We owe him thanks for furnishing the interesting information which forms the basis of this paper and for permitting the writer to submit it to our Society.

CARBIDE SEGREGATION IN HIGH SPEED STEEL

By A. E. White

Abstract

This paper points out that the degree of segregation in high-speed steel depends upon the casting temperature, the rate of cooling the ingot and the degree of mechanical reduction in the mills. Manufacturers of steel are cognizant of these factors and by careful control are attempting to eliminate as far as possible segregations in the final product.

The time is now ripe for experimental work in this field along lines somewhat more drastic than has been the case in the past. The user of tool steels usually has given little attention to these matters, his attention being from a complaintive rather than a constructive standpoint. The useful life of a tool rests as much in the hands of the user as it does in the hands of the manufacturer. Its life depends upon many factors, chief among which are the proper form of cutting edge, the rate of feed and the speed at which either the tool or work is moving as well as the necessity of proper lubrication. It is indicated that the next few years will bring about fundamental improvements in the manufacture of high-speed steel and that it is necessary that the consumer and manufacturer work closer together.

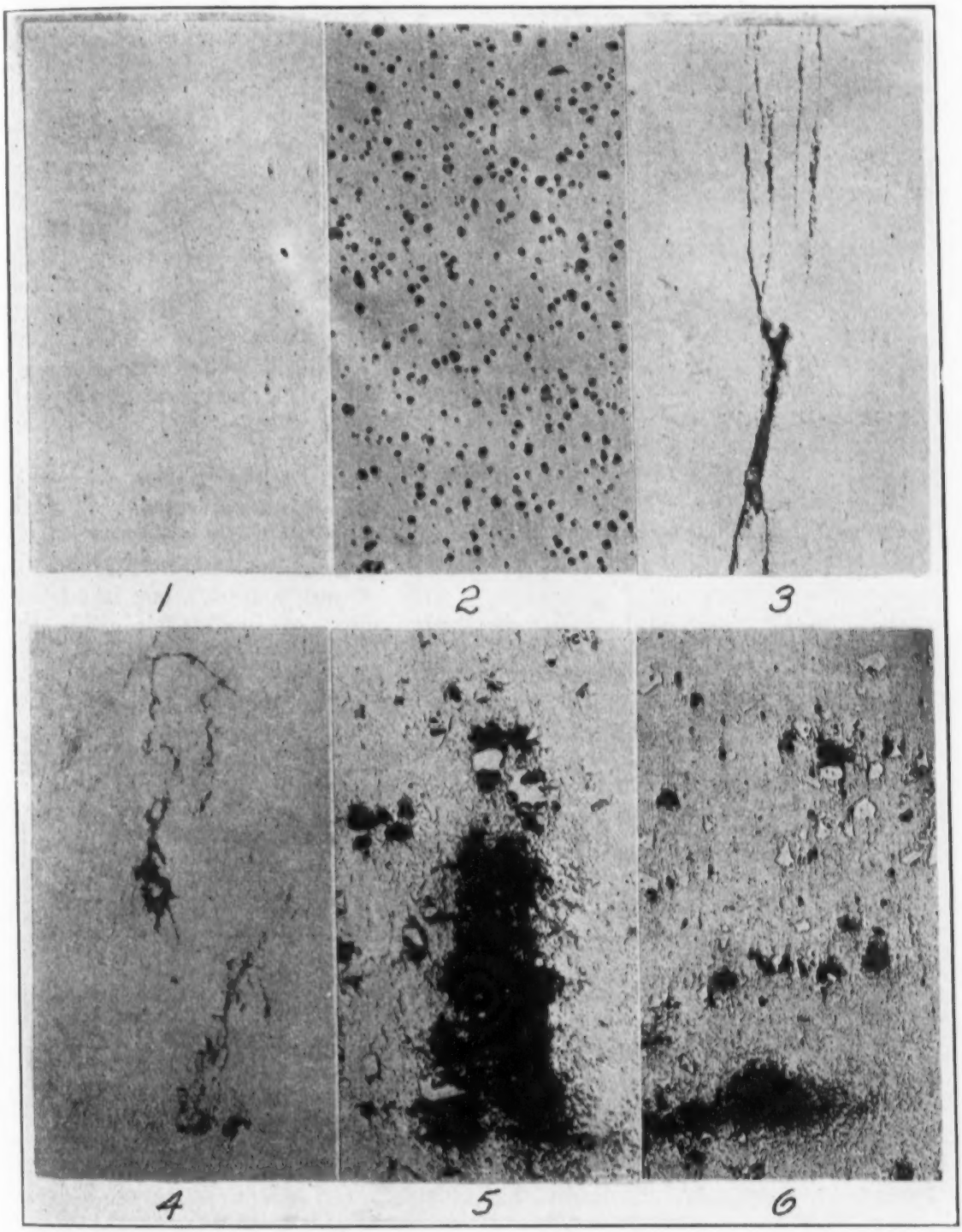
IN 1784, at approximately the time when this nation was founded, crucible steel was first produced. In 1900 Taylor and White announced to the world high-speed steel. Since 1900 there have been no outstanding changes in the composition of this steel and since 1784 there have been no outstanding changes from a metallurgical angle, although there have been outstanding changes from a fuel efficiency angle, in the crucible process. This is the process by which large quantities of high-speed steel are today made.

Beginning with the 20th century there has been an increased use of the electric furnace. This type of furnace and the crucible furnace share the honors in the making of high speed steel. The electric furnace has not been universally adopted for this class of work and there are those that state, among them the firm that first introduced an electric furnace into this country, and who are strong advocates for its use in the production of alloy steel, that the crucible process, by and large, is superior to the electric furnace process for the production of high-speed steel.

It is not the purpose of this paper to defend either the crucible or the electric furnace process. Each one has certain advantages over the other, and the question as to superiority therefore, becomes fundamentally more a question of plant operation than of process superiority. Thus in the electric furnace it is possible to get higher temperatures; with a resultant possibility of slag diminution in the steel. On the

---

A paper presented at the Detroit Convention of the Society, October 2-7. The author, A. E. White, is director of the Department of Engineering Research, University of Michigan, Ann Arbor, Mich.



HIGH SPEED STEEL DEFECTS

Fig. 1—Cross Section of an Average Acceptable Structure. Fig. 2—Cross Section of Specimen Showing Excessive Inclusions. Fig. 3—Longitudinal Section Showing Typical Slag Inclusions. Fig. 4—Cross Section Showing Typical Slag Inclusions. Fig. 5—Longitudinal Section Showing Badly Contaminated Metal. Fig. 6—Cross Section of Same Specimen as Fig. 5. All Specimens Are in the Unetched State. All Magnifications. X 100

other hand, the impracticability, one might almost say the impossibility, of accomplishing any refining in the crucible process gives greater assurance of a better deoxidized metal and in the production of steel in which a master ladle is not employed a probable decided reduction of the entrained slag content. These respective advantages are presented for the purpose of pointing out the probable impossibility of dogmatically stating that one process, because of the process itself, is superior to the other.

Governing Factors

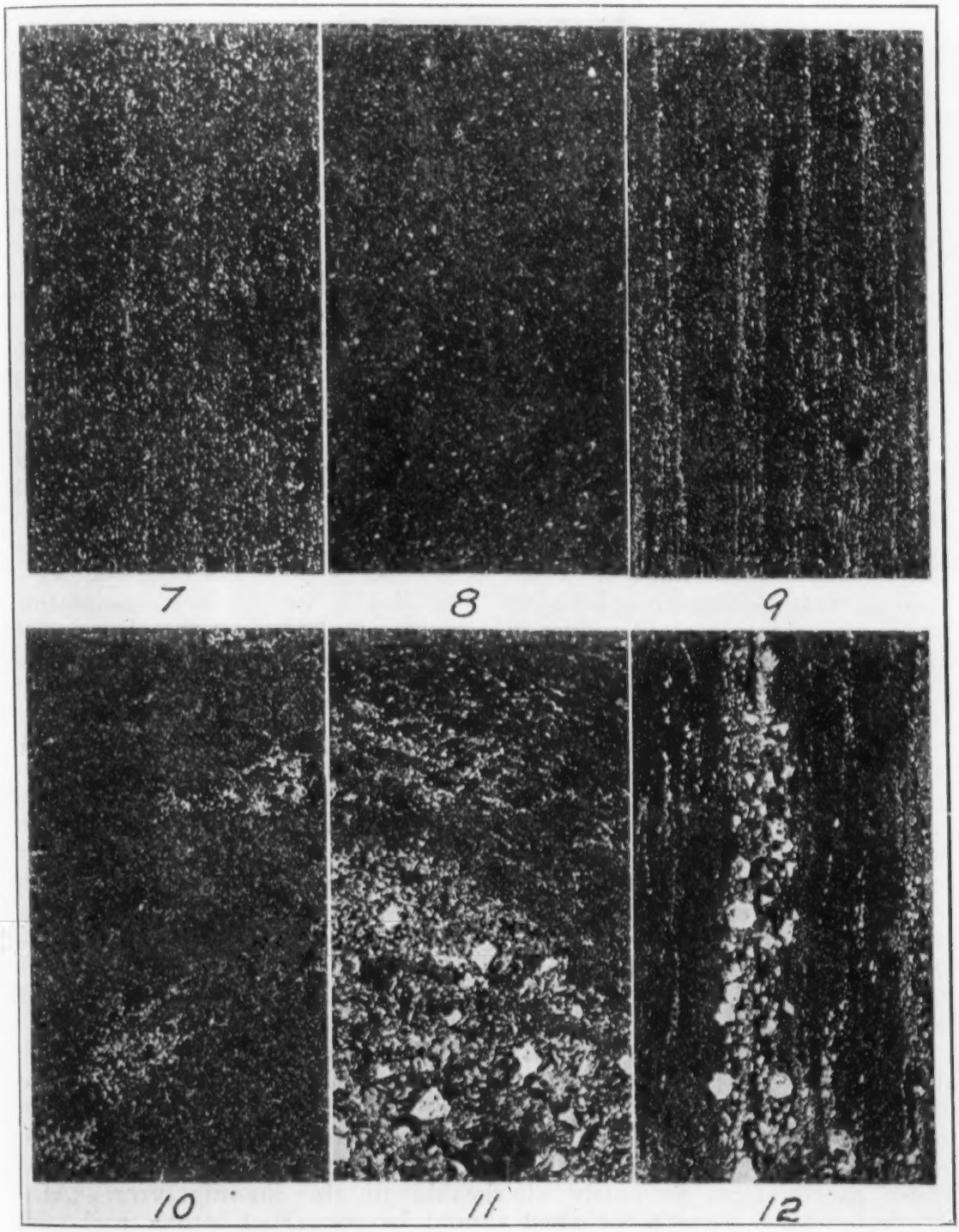
The troubles generally encountered in high-speed steel chargeable to the steel manufacturer are not due to the refining or melting methods employed, but rather to the conditions which take place during the cooling of the steel from the molten to the solid state. Certain of these defects are chargeable to faulty practice and any steel manufacturer thus guilty usually acknowledges the trouble and willingly replaces the steel. Thus steel with an excessive quantity of contained slag is of this type.

Several photomicrographs illustrating this condition setting forth both the good and the bad are submitted. Fig. 1 represents the average unetched appearance of acceptable stock. Fig. 2 represents the appearance in an unetched condition of bar stock containing a large number of evenly distributed inclusions. Figs. 3 and 4 show slag inclusions in the longitudinal and cross sectional views of bar stock. Though not universally present in high-speed steel, yet inclusions of this size are frequently encountered. Figs. 5 and 6 illustrate the appearance of steel excessively defective. Fig. 5 is a longitudinal section and Fig. 6 is a cross section. These defects are due entirely to what is recognized to be faulty manufacturing operations. They are not universally present and but a small percentage of the steel is thus defective.

The outstanding trouble in high-speed steel chargeable to the steel mill is segregation of the carbides. The elimination of this trouble is not in sight. It is a trouble resulting from the tendency on the part of the components making up a metal, especially the carbides in high-speed steel, to segregate. As long as cooling methods of a type which allow segregations to take place are employed, just so long will this trouble be found in high-speed steel, especially in the steel of the larger sizes. Numerous types of segregation found in current bar stock are submitted in photomicrographs Figs. 9 through 12 inclusive.

The excessive segregations can be lessened and in some cases eliminated provided the metal is reduced in cross section sufficiently, but in many of the commercial sizes of high-speed steel it is impossible to provide the required degree of reduction. For the most part it is present to a greater degree in the interior of a given piece than it is in the exterior of a given piece. For instance, photomicrographs Figs. 13 and 14 indicate the appearance of the longitudinal section and photomicrographs Figs. 15 and 16 the appearance of the cross section at the center and at the outside. A decidedly segregated structure is noted in those taken at the center and an absence of bands is noted in the others.

Micrographs Figs. 17 and 18 set forth the part location of sample



TYPES OF CARBIDE SEGREGATIONS IN HIGH SPEED STEEL

Fig. 7—Longitudinal Section Showing Excellent Structure. Fig. 8—Cross Section of the Same Specimen. Fig. 9—Longitudinal Section Showing Average Structure at Center of Bar Stock Over ¾ Inches in Diameter. Fig. 10—Cross Section of Same Specimen. Fig. 11—Cross Section of Badly Segregated Stock. Fig. 12—Longitudinal Section of Same Specimen. All Magnifications X 100

plays in the matter of carbide segregation more effectively, possibly, than the photomicrographs.

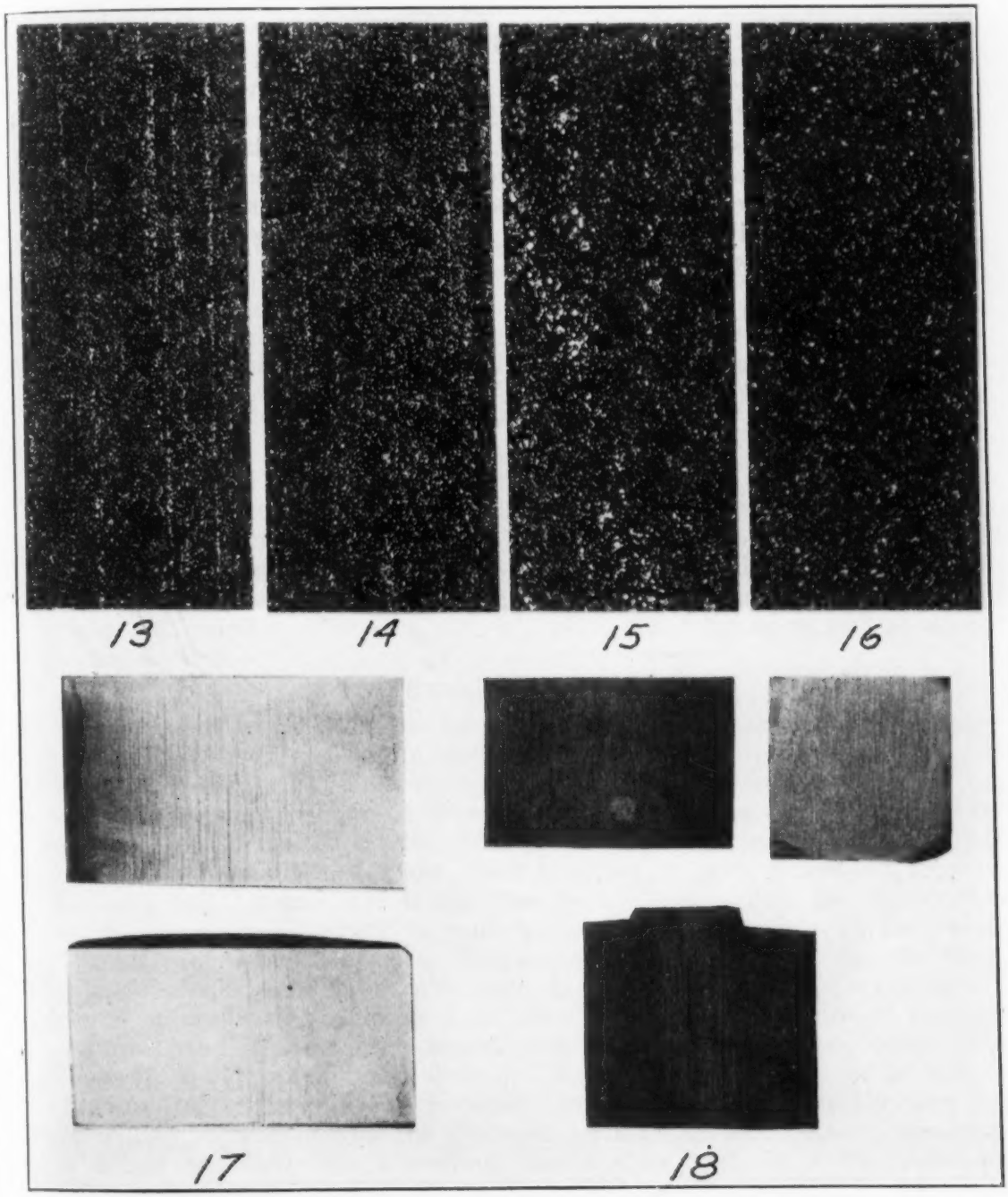
Casting Temperature Important

The degree of segregation is dependent upon initial casting temperature, rate of cooling from the liquid to the solid state, and degree of reduction. All of these factors are appreciated by the steel mills and there is no question but that all of the mills are engaged in a sincere effort to so control these factors as to get minimum segregation. Yet these efforts, commendable as they are, appear to be in the form of a palliative rather than a cure. The time is ripe for experimental work in this field along lines somewhat more drastic than has been the case in the past when we consider there have been no changes of moment affecting the elimination of segregation for over a hundred years. Is the time not now ripe for a thorough investigation of this matter? Can we this day answer what effect the centrifugal casting of high-speed steel would have in the elimination of this segregation? Or who can predict what would be the effects of casting under pressure, or what effects would result from radical changes in the reduction operations or from a radical change in the shape into which the steel is first cast? May we not go so far in our imagination as to wonder if the day will come when we will convert steel from the liquid to the solid state by some such process as is now used in converting molten glass to solid glass? Especially worthy of consideration is the investigation of the effect of centrifugal casting on the elimination of segregation. This is a matter which it is believed should be given a most thorough trial in order to ascertain if it would not materially reduce segregation.

No attempt has been made to prepare this paper from the standpoint of either the high-speed steel manufacturer, the tool manufacturer or the tool user. There are men in each of these three lines, who, because of their special privileges and opportunities, are in a much better position to speak on this subject than is the writer. As a matter of fact, some very excellent presentations in these fields have been made by some of our steel mill metallurgists and by some of the metallurgists connected with certain of our tool manufacturing establishments, although it is with deep regret that the policies of certain companies in this field prevent their men from taking part in these discussions to a degree that would be of greatest benefit.

The consumer has given little attention to these matters. Such attention as he has given has been rather from the complaint rather than from the constructive side. Intelligent consideration must be given to this whole subject. To give the greatest life high-speed steel should be of the proper composition and free from segregations and inclusions. These are matters primarily chargeable to the manufacturer. Also for the greatest service the steel should be converted into a tool possessing a proper shape, a proper edge and, if shipped from the tool manufacturer's plant in the hardened condition, a proper degree of hardness. These are conditions which are fundamentally chargeable to the tool manufacturer. For further satisfactory service a tool must be at all times properly sharp, it must have the proper angle for cutting, it must be properly lubricated, it must be run at a proper speed, there

must be a proper rate of feed, there must be an absence of an uneven loading, and proper care and supervision must be taken in other matters of a similar character. It would appear, therefore, that proper tool life is as much in the hands of the consumer as it is in the hands of the steel manufacturer or tool maker. Experiments of any type are ex-



RELATION OF LOCATION OF SECTION TO CARBIDE SEGREGATION IN HIGH SPEED STEEL

Fig. 13—Longitudinal Section at Center of Bar. X 100. Fig. 14—Longitudinal Section at Edge of Bar. X 100. Fig. 15—Cross Section at Center of Bar. X 100. Fig. 16—Cross Section at Edge of Bar. X 100. Fig. 17—Entire Sections of Bars. X 1.75. Fig. 18—Entire Sections of Bars. X 1.75

pensive. Ultimately someone must pay that cost. If researches are instituted by a steel mill which result in an improvement in their product with a resultant demand for their product, the costs of such research are, in the end, unquestionably paid by the consumer. The consumer is the one that most benefits and also the one who pays the cost of the work.

Conclusion

It is very probable that the next few years will witness some very fundamental improvements in the manufacture of high-speed steel. It is hoped, however, that the triangular bond between the steel maker, the tool maker and the tool user, each to the other, will be appreciated, and that through co-operative work results will be forthcoming which will give to industry tools possessing the proper characteristics for maximum service.

THE EXECUTIVE AND RESEARCH

By John A. Matthews

Abstract

The author of this paper who is a very capable metallurgist, having gone through the periods of early training, in the shop, mill and laboratory, has arrived at the high station of chief executive of his company. His paper gives the viewpoint of an executive and the thoughts he has developed are very valuable. His views are particularly valuable because he can share mutually the viewpoints of the research worker and his problems. Likewise he shares mutually the viewpoints of the executives who must direct the policies of their organizations.

THE popular conception of research, I am convinced, is a misconception. To the man in the street research suggests a laboratory and a genius of the high-brow type presiding over it. He is generally supposed to be a dreamer and probably impractical. Interest in the results of research as far as the public is concerned, is apt to be centered in those that appeal to the imagination rather than to reason. The spectacular invention or discovery is what is expected by the public from a research laboratory. The plain literal meaning of the word research—to search again, the facts, processes and phenomena of everyday life to find new relations, laws and results, is less often considered and this phase is of less general interest to the public mind. The full definition of research is to search or examine with continued care; to examine into or inquire about diligently. The field of research is not, therefore, limited to science; it embraces all branches of knowledge and human endeavor, of conduct, economics, history, civics, and religion, as well as science and engineering.

The Executive's Function

The executive function has to do with executing, performing or carrying into effect laws, policies or orders of higher constituted authority. By definition the executive is not supposed to originate actions but to carry out the wishes and instructions of others. This is not true today, even of the President of the United States, notwithstanding the specific functions laid down in the constitution for the three branches of government,—Executive, Legislative and Judicial. It is not true in business, either, for the modern executive of a great corporation must possess initiative and is, in fact, more or less of a dictator of policies. His authority is so absolute that the function with which he is often connected is that of executioner,—cutting off heads of subordinates. That is a mistaken view, frequently born of unhappy experiences and it should be remembered that every executive desires most strongly to build up and not destroy. Even though he may be a dictator in a certain sense, he is held accountable for his acts by the stockholders and their chosen representatives, the directors. He is, in fact, between an upper and nether millstone—the avaricious stockholders and the more avaricious employes, the one demanding more profits and lower costs, and the other more money and less production. How else can a man in that position satisfy everyone without the aid of research, not research of the narrower sort from

A paper presented before the Detroit Convention Research Symposium, Oct. 2-7, 1922. The author, Dr. John A. Mathews, is president of the Crucible Steel Company of America.

a special laboratory and special group of men, but research in its broadest aspect as affecting every operation, process and product, participated in by technicians, foremen and superintendents and not infrequently by alert workmen?

In an address to the engineering division of the National Research council, about a year ago, I said that commercial research has for its principal purpose the increasing of profits. That is what manufacturing concerns are operated for and all departments of the organization must be co-ordinated so as to lead to profitable operation. Without this, failure is inevitable. Legitimate manufacturing profits are the reward the public pays for services rendered or risk taken. The desire for profits is the impelling motive that leads investors to take risks and build up industries that give employment to others.

The Research Department's Function

The research department of a company may function in many ways to contribute its part to this success; 1. It may endeavor to improve the product which leads to greater demand, larger output, greater ability to meet competition, and the ability to command higher prices. 2. It may direct its efforts toward lowering costs (a) by finding cheaper but satisfactory raw materials: (b) by improving old processes to increase yield or decrease labor, or both; (c) by developing new products and finding uses for by-products; (d) by finding new uses for existing products; (e) by improving operating conditions in the plant not directly connected with the product itself, such as effecting savings in water, fuel, lubrication and electricity, and by improving the working cycles, material movements and power conditions. All of these result in public good and bring their reward because they lead to better goods, cheaper goods, or the better supplying of the public needs.

Research in this broader sense, as well as in the restricted sense of the pure scientist must be actuated by the spirit of a search after truth. The fact that the research is for a specific purpose—profits—must not be allowed to interfere with the spirit and method that should control all research efforts whether the object is truth for truth's sake, or truth for profit's sake.

It is improbable that commercial research can adopt co-operative methods in peace times, to the extent that is possible in pure science efforts, where the competitive factor is lacking. There are exceptions to this, however, as is evidenced by such splendid examples of co-operation as in the study of the fatigue of metals, of rock-drill steels, the gage steel researches, all of which I have had the privilege of participating along with other steel men.

There will exist a natural bond of sympathy and understanding between the executive and the research worker, when each recognizes that his conclusions to be valid, must be arrived at by the same method,—the scientific method, whereby sound judgments are the result of a logical weighing of facts and events, their sequence and relationship. Each will better understand the other if he will ponder the words of Doctor Karl Pearson, quoted from his introduction to the "Grammar of Science," and in conclusion I will leave with you his words of wisdom upon the meaning, purposes and scope of science and the development of the scientific frame of mind.

Research—The Scientific Method of Examining Facts

"The classification of facts and the formation of absolute judgments upon the basis of this classification—judgments, independent of the idiosyncrasies of the individual mind—essentially sum up the aim and method of modern

science. The scientific man has above all things to strive at self-elimination in his judgments, to provide an argument which is as true for each individual mind as for his own. The classification of facts, the recognition of their sequence and relative significance is the function of science, and the habit of forming a judgment upon these facts unbiased by personal feeling is characteristic of what may be termed the scientific frame of mind. The scientific method of examining facts is not peculiar to one class of phenomena and to one class of workers; it is applicable to social as well as to physical problems, and we must carefully guard ourselves against supposing that the scientific frame of mind is a peculiarity of the professional scientist.

"*Science,* indeed, often teaches us facts of primary importance for practical life; yet not on this account, but because it leads us to classifications and systems independent of the individual thinker, to sequences and laws admitting of no playroom for individual fancy, must we rate the training of science and its social value higher than those of philology and philosophy. The first aim of any genuine work of science, however popular, ought to be the presentation of such a classification of facts that the reader's mind is irresistibly led to acknowledge a logical sequence—a law which appeals to the reason before it captivates the imagination. Let us be quite sure that whenever we come across a conclusion in a scientific work which does not flow from the classification of facts, or which is not directly stated by the author to be an assumption, then we are dealing with bad science. Good science will always be intelligible to the logically trained mind if that mind can read and translate the language in which science is written. The scientific method is the method of all logically trained minds. I believe more will be achieved by placing instruction in pure science within the reach of all our citizens, than by any number of polytechnics devoting themselves to technical education, which does not rise above the level of manual instruction.

Field of Scientific Research Unlimited

"The field of science is unlimited; its material is endless, every group of natural phenomena, every phase of social life, every stage of past or present development is material for science. The unity of all science consists alone in its method, not in its material. The man who classifies facts of any kind whatever, who sees their mutual relation and describes their sequences, is applying the scientific method and is a man of science. It is not the facts themselves which form science, but the method in which they are dealt with.

"Every great advance of science opens our eyes to facts which we had failed before to observe, and makes new demands on our powers of interpretation. This extension of material of science into regions where our great-grandfathers could see nothing at all, or where they would have declared human knowledge impossible, is one of the most remarkable features of human progress. Great as the advance of scientific knowledge has been, it has not been greater than the growth of material to be dealt with. The goal of science is clear—it is nothing short of the complete interpretation of the universe. But the goal is an ideal one—it marks the direction in which we move and strive but never a stage we shall actually reach. The universe grows ever larger as we learn to understand more of our corner of it."

GAS USEFUL IN HEAT TREATING ROOM

By J. Weaver Smith

Abstract

The author discusses the practical application of city gas or manufactured gas in the heat treating room. The convenience of using gas as a fuel is pointed out and its wide application to all types of industrial heating is shown in the accompanying illustrations.

Burner design, furnace design and the effects of using equipment of improper design are discussed. The wide application and ready accessibility of city gas has shown that it can be used economically and efficiently and compares favorably to other types of fuel. Furthermore it is clean and easily handled.

IT IS the purpose of this paper to offer a few practical suggestions as to what may be accomplished by the use of city gas for heating operations in and around the heat treating room.

In some instances the production manager, superintendent, or foreman, has been very liberal and provided appliances with great excess capacity for the work for which they were intended. On the other hand, the average man provides appliances which either have insufficient capacity or very inefficient operation, very little or no thought being given to burner design, and consequently the operation is usually a failure from an economical standpoint, and in many instances the actual production results desired are not obtained.

Today most gas companies maintain an industrial department of capable engineers for the sole benefit of the various industries in the locality, and for whose services no charge is made. Many heating problems are quickly solved by the industrial gas engineer due to his wide and varied experience. There is also maintained a stock of appliances and burners for industrial purposes, and these engineers are prepared to design and build special equipment when necessary.

One of the most common operations around a manufacturing plant is that of boiling large quantities of water, lye, or other cleaning solutions. There are various methods of doing this. Steam is most generally used for this purpose, either by means of a coil in the tank or exhausting the steam directly into the liquids. Sometimes steam is not available, especially in the smaller plants. To meet this condition there is the automatic gas-fired steam boiler built in units of 1 to 25 horsepower. Figs. 1 and 2.

These boilers are very compact and comply in every respect with the A. S. M. E. code and state inspection laws. They will automatically maintain a constant pressure. They usually have about three times as many tubes as the same capacity coal-fired boiler, and consequently a very much higher efficiency. The gas consumption averages about 75 cubic feet per horsepower hour of steam consumption.

In order to compute the weight steam required to raise a given

Acknowledgement is made to *Gas Age-Record* for the use of the cuts illustrating this paper.

A paper presented before a meeting of the Society. The author J. Weaver Smith, is industrial engineer, with the Citizens' Gas Co., Indianapolis, Ind.

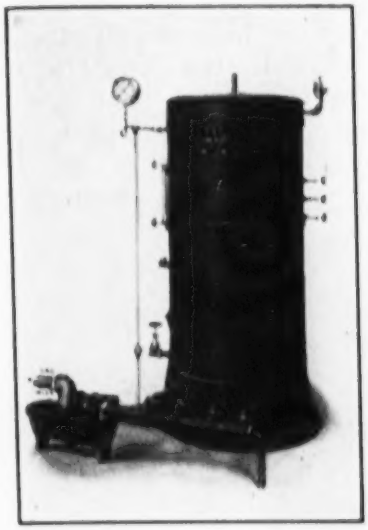


Fig. 1—Automatic Gas-fired Boiler

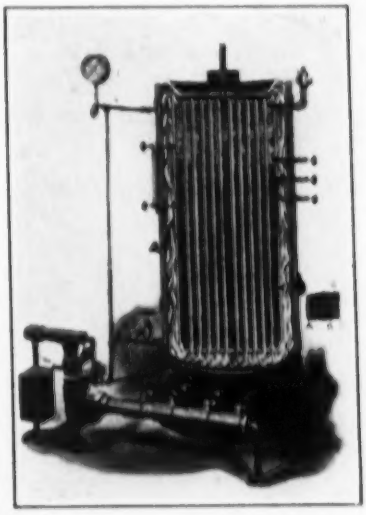


Fig. 2—Cross-Section of Automatic Gas-fired Boiler

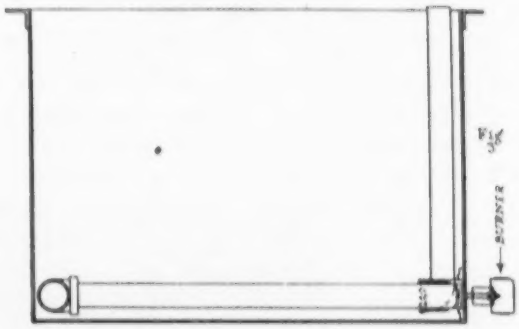


Fig. 3—Side View of Tank Heated by Internal Method

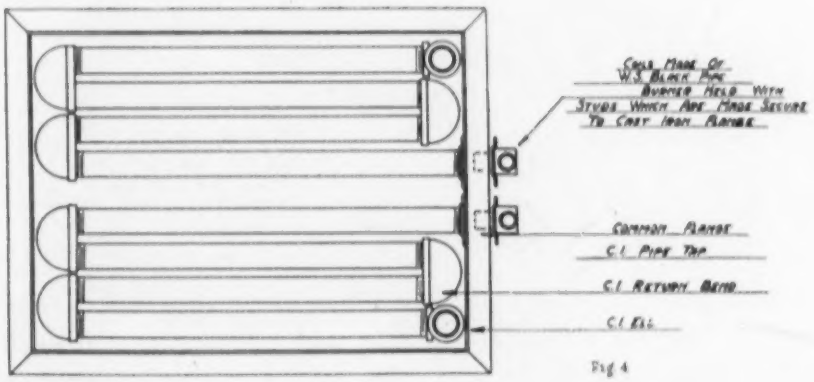


Fig. 4—Top View of Internally Heated Tank

volume of water to any given temperature, multiply the pounds of water to be heated by the difference of temperature between it and that to which it is to be raised, for a dividend; then to the temperature of the steam add 966.6 degrees Fahr., and from that sum take the required temperature of the water for a divisor; the quotient will give the weight of steam. The weight of one horsepower of steam is approximately 30 pounds. The flow of steam in pounds per second through a nozzle

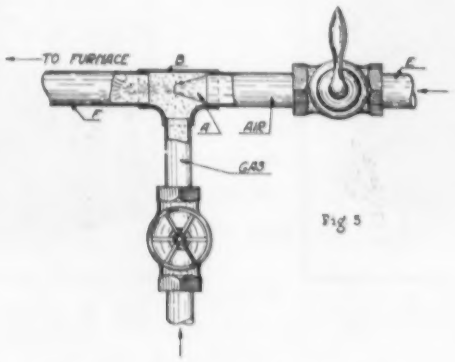


Fig. 5—Siphon Blast Mixing Tee

equals the absolute pressure in pounds per square inch by the area in square inches of the nozzle divided by 70.

Other methods are the uses of coal fires and oil burners under the tank. These are more or less objectionable due to lack of cleanliness, floor space, ease of operation, etc. Then, too, we have the method of placing gas burners under the tank. The author's observation has been that by burning the fuels under the tank, an efficiency of only 10 to 30 per cent is obtained. A much better method is what is known as the internal heating method, Figs. 3 and 4.

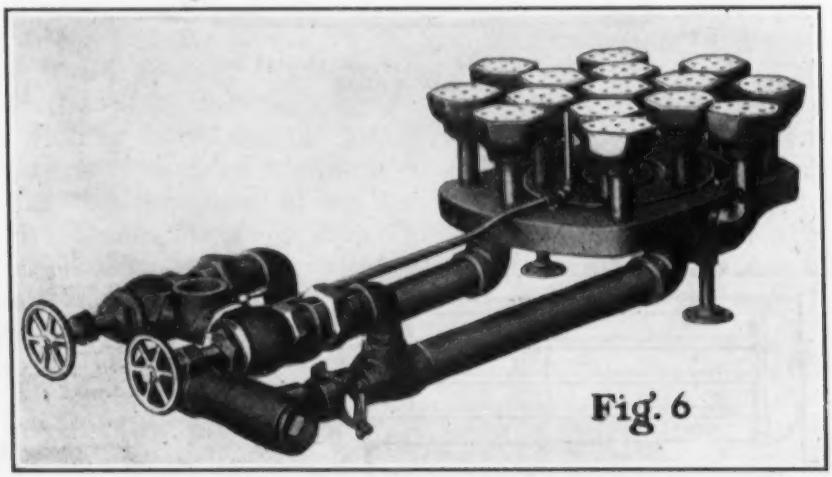


Fig. 6—Pyrogenetic Burner Group

This consists of the use of a coil of large size black iron pipe in the tank and resting on the bottom, one end projecting through the side or end of the tank, and the other end rising in the corner above the water level. A blast burner pointed directly into and placed about ¾

inches from the lower end of the coil, burns a high temperature flame within the coil and the heat is dissipated directly into the liquid. While the temperature of the flame on entering the coil may be about 1800 degrees Fahr., the temperature at the upper end of the coil is only about 150 degrees Fahr. Thus a very high efficiency is obtained. Not only

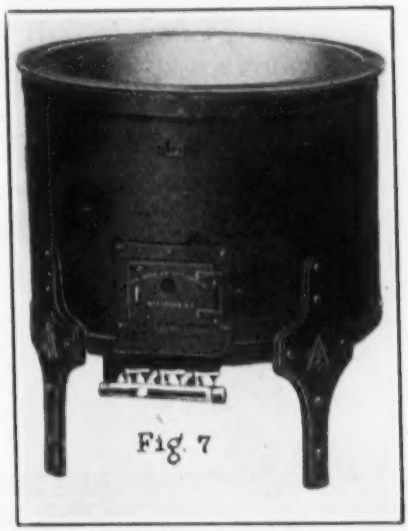


Fig. 7—Cauldron Furnace, Gas-fired

Fig. 8—Gas-fired Soda Kettles

this, but the liquid is brought to the boiling point very much more rapidly. In one instance this time was reduced from three hours to only twenty minutes. The amount of water boiled was approximately 165 gallons. Without taking into consideration the loss of heat through the walls of the tank and the top of the liquid, an efficiency as high as 95 per cent has been obtained. The loss of heat through the walls of the tank is from 10 to 12 B.t.u. per square foot of radiation per degree difference in temperature per hour. The loss of heat from the top of the liquid is in excess of this amount, probably 25 per cent more. With

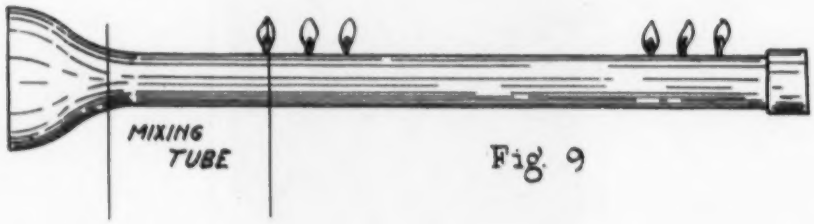


Fig. 9

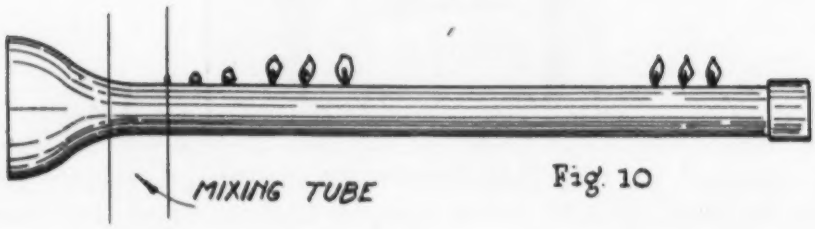


Fig. 10

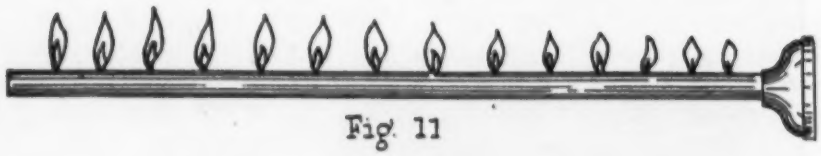


Fig. 11

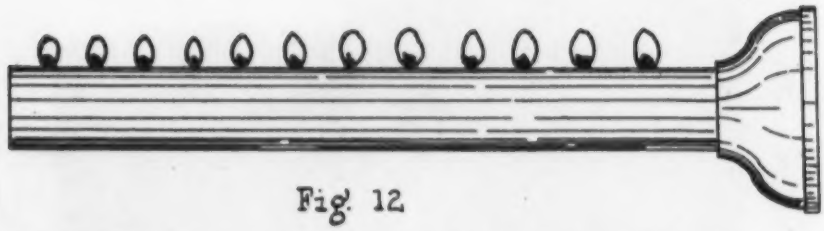


Fig. 12

Fig. 9—Pipe Burner with Proper Length of Mixing Tube. Fig. 10—Mixing Tube Too Short. Fig. 11—Burner Tube Too Small. Fig. 12—Burner Tube Too Large

large tanks holding 10,000 to 15,000 gallons or more, it is necessary to use two or more coils with a burner for each, so as to burn a sufficient amount of gas to provide the required amount of heat.

For the purpose of providing the proper mixture of air and gas and the consequent blast flame in this operation, the use of a premixing blower and burner nozzle is recommended, but never more than one burner nozzle to one premix, due to the explosive nature of the mixture and consequent danger from back fire.

Where the plant has a surplus of positive pressure air near at hand, the use of the siphon blast mixing tee in conjunction with a blast burner

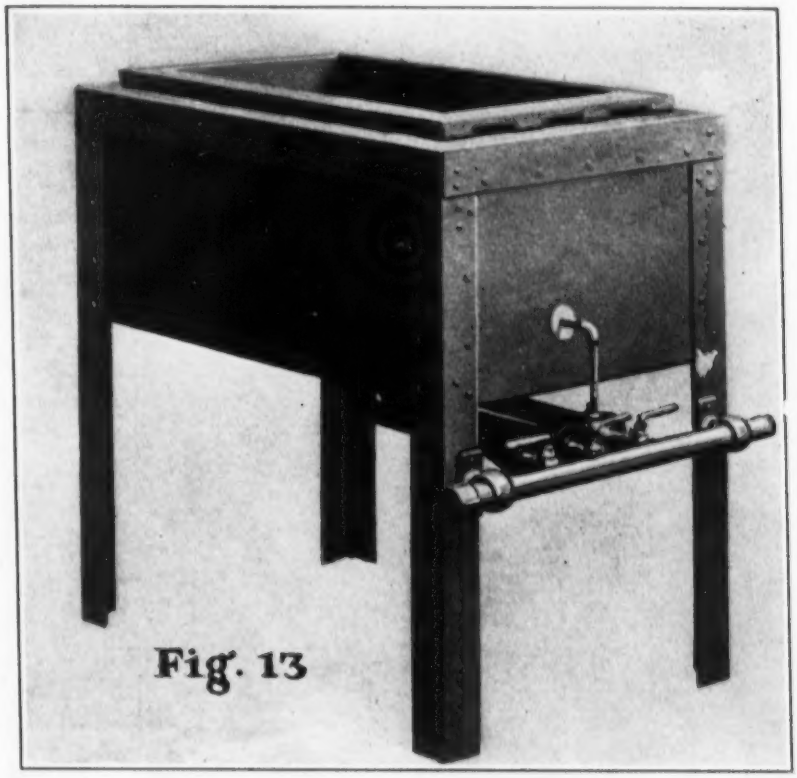


Fig. 13—Gas-fired Oil Tempering Furnace

nozzle, is recommended. The Zander burner has also been used successfully.

In this connection it might be well to state that the average man gives little or no thought to the use of the siphon blast mixing tee when constructing an appliance with blast burners. This is an exceedingly important detail, which, when overlooked, is generally a source of much annoyance and trouble.

As shown in the illustration, Fig. 5, the air coming from the supply pipe E at a pressure of ½ to 2 pounds per square inch, passes through nozzle A with a high velocity. This tends to form a slight vacuum in the mixing tee B, and the gas is drawn in from the side outlet of the tee. The air and gas then pass on together into the mixing tube F where they become thoroughly mixed, and thence to the burner. The essential features are the nozzle A which must project exactly one-eighth of an inch beyond the center of the tee, and the mixing tube F which must be of sufficient length to properly mix the air and gas.

Constructing Blast Burners

In designing and constructing blast burners it is well to remember the formula $Q = AV$, in which Q is the gas consumption, A is the area of the burner ports in square inches, and V is the velocity of the mixture of air and gas. Also that a velocity of more than 75 feet per second will blow the flame off the burner, and that a velocity of less than 25 feet per second will cause the burner to back-fire. Thus if we desire to

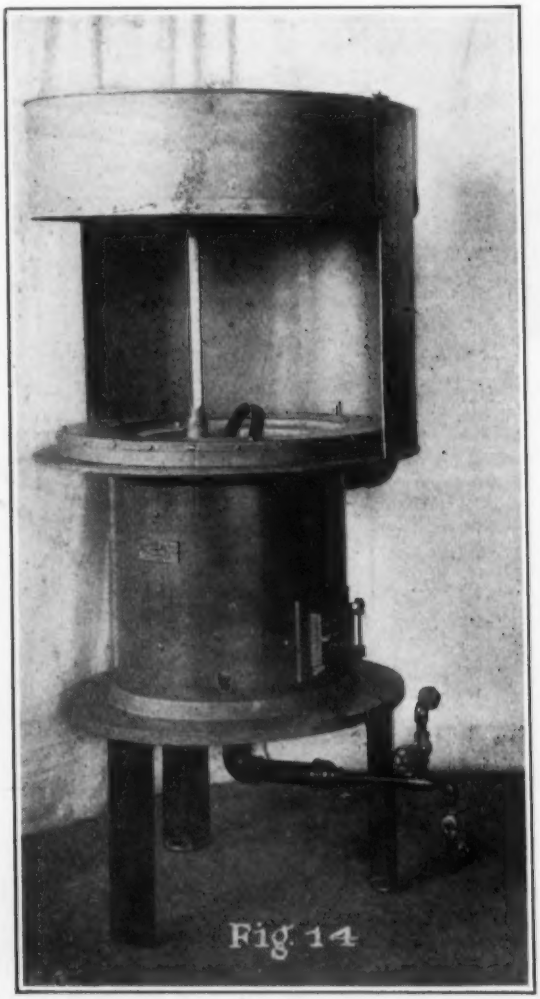


Fig. 14—Gas-fired Oil Tempering Furnace

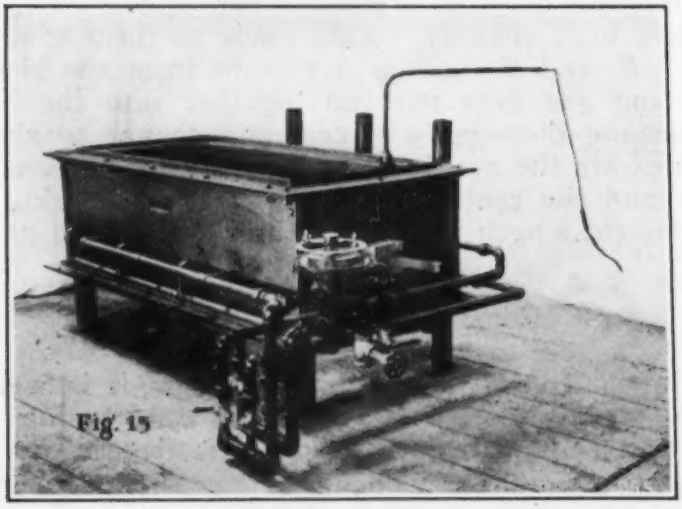


Fig. 15—Gas-fired Oil Tempering Furnace with Automatic Temperature Control

find the area of ports of a burner to consume 50 cubic feet of gas per hour with five parts air.

50 cubic feet = gas consumption
250 cubic feet = air consumption
75 feet per second = velocity

Then we have 300 cubic feet total consumption per hour divided by 3600 seconds, equals the consumption per second or 0.83 cubic feet. Substituting in the formula,

$$0.83 \text{ cubic feet} = A \times 75 \text{ feet}$$

$$A = \frac{0.83 \text{ cubic feet}}{75 \text{ feet}}$$

$$A = 0.011 \text{ square feet}$$

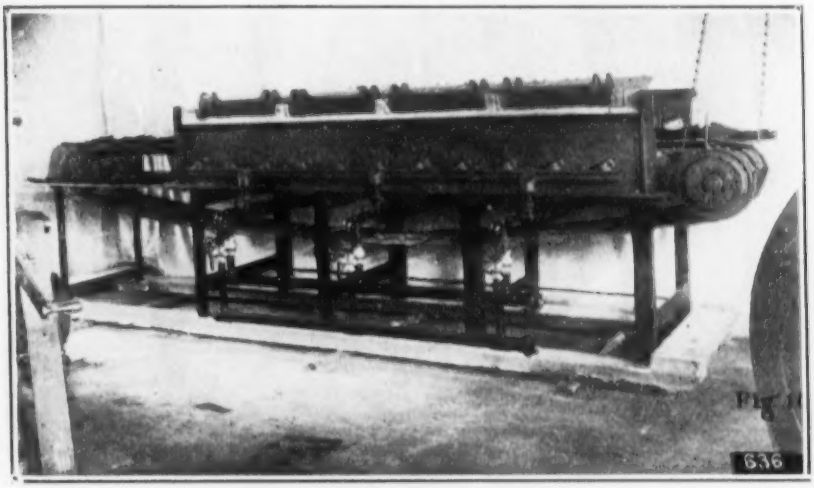


Fig. 16—Gas-fired Heating Machine for Tempering Agricultural Implements

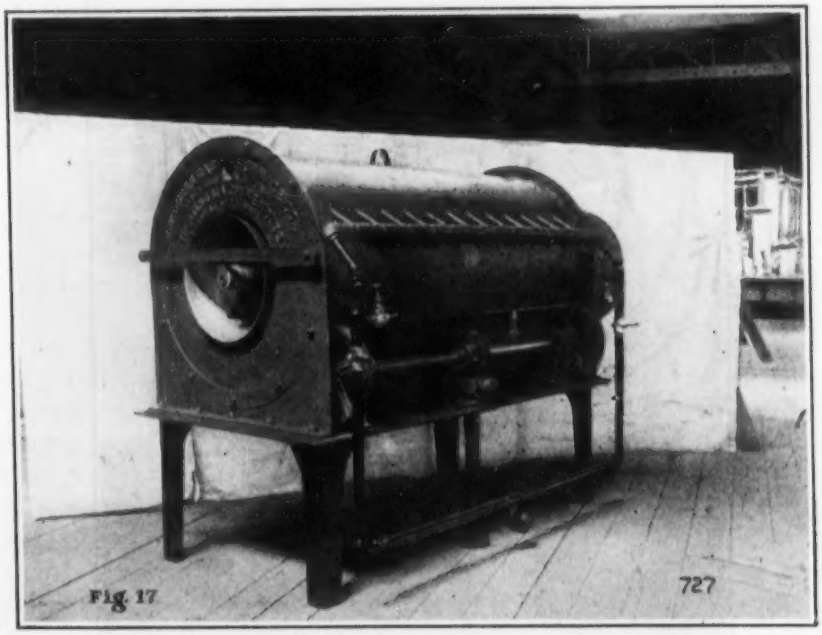


Fig. 17—Heating Machine for Sand Tempering or Coloring, Gas-fired

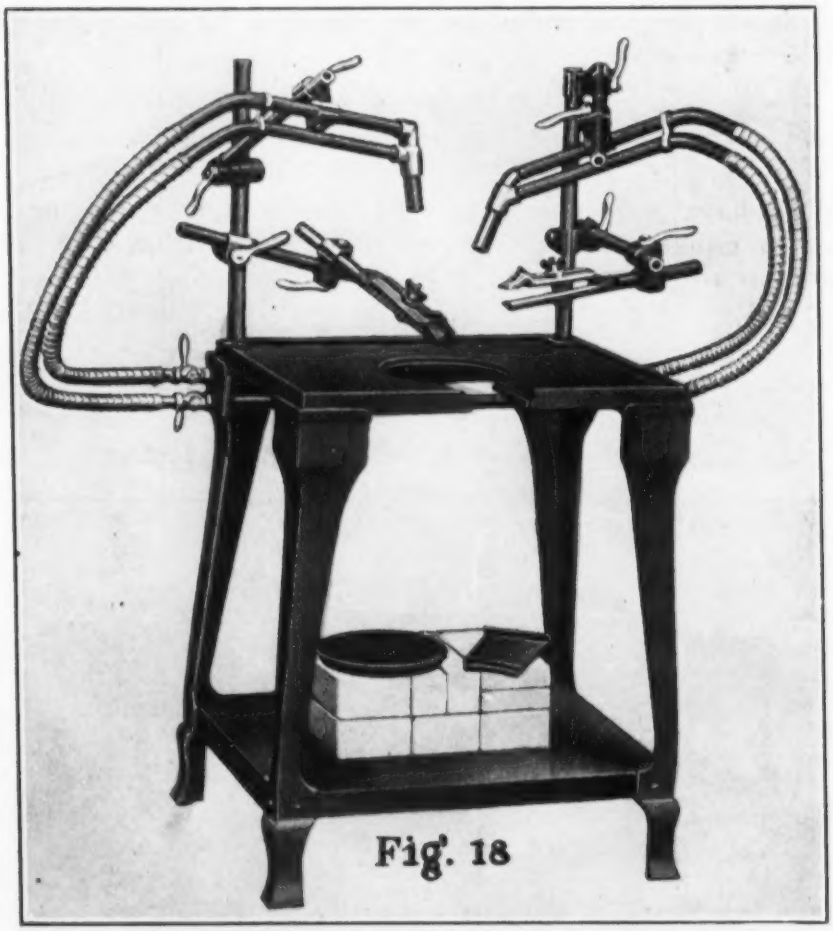


Fig. 18—Brazing Table Showing Arms for Holding Work, Gas-fired

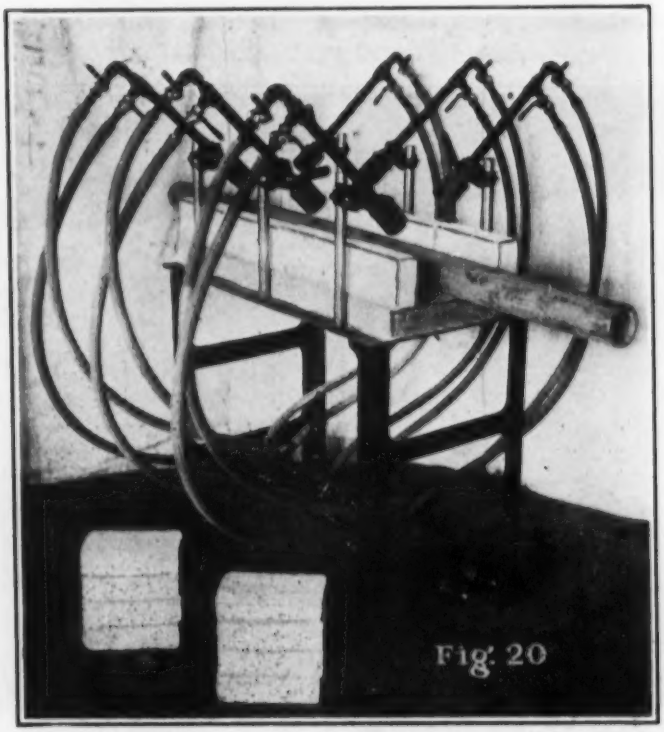


Fig. 20—Brazing Table for Brazing Pipe and Tubing

0.011 square feet x 144 equals 1.584 square inches or total area of ports. If four ports are desired, divide 1.584 square inches by 4 to find the area of one port.

Now to return to the subject of heating liquids for cleaning purposes, there are many places where only a few parts are to be cleaned and

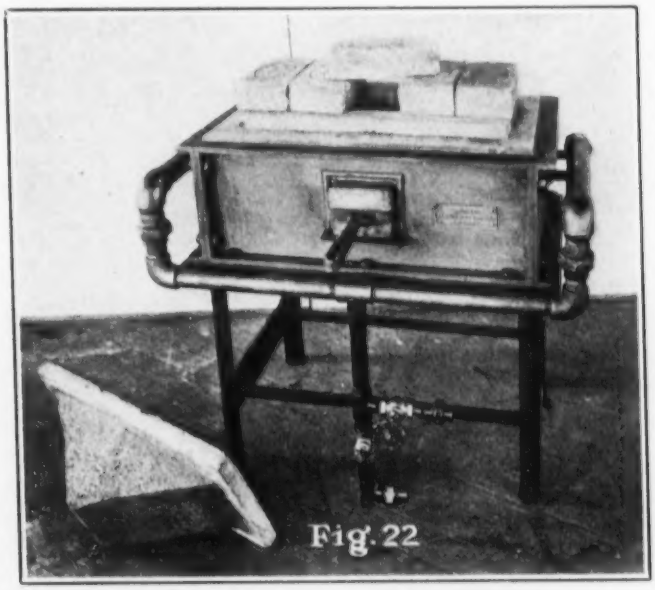


Fig. 22—Gas-fired Furnace for Dip Brazing

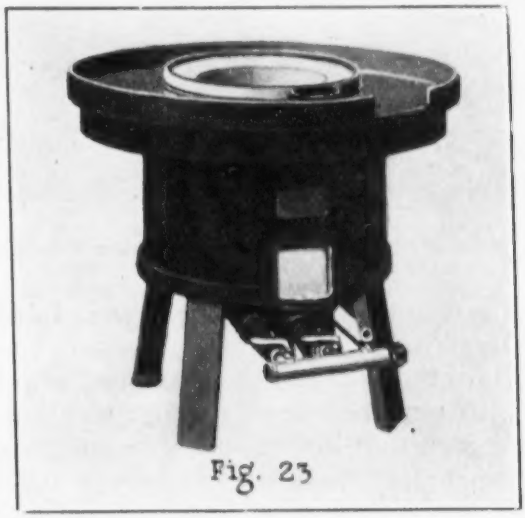


Fig. 23—Tinning Furnace with Pre-heater

the use of gasoline is objectionable. To meet this condition we have cauldron furnaces (Fig. 7) and soda kettles (Fig. 8) of various sizes up to 300 gallons capacity and heated by means of gas burners of the atmospheric mixer type and pyrogenetic type, Fig. 6.

These are much more efficient than home-made equipment due to better insulation and construction and are highly recommended. However, some plant managers are unwilling to pay the higher first cost for these appliances, and endeavor to get the same results from very crude home-made equipment. To them a few words regarding the proper de-

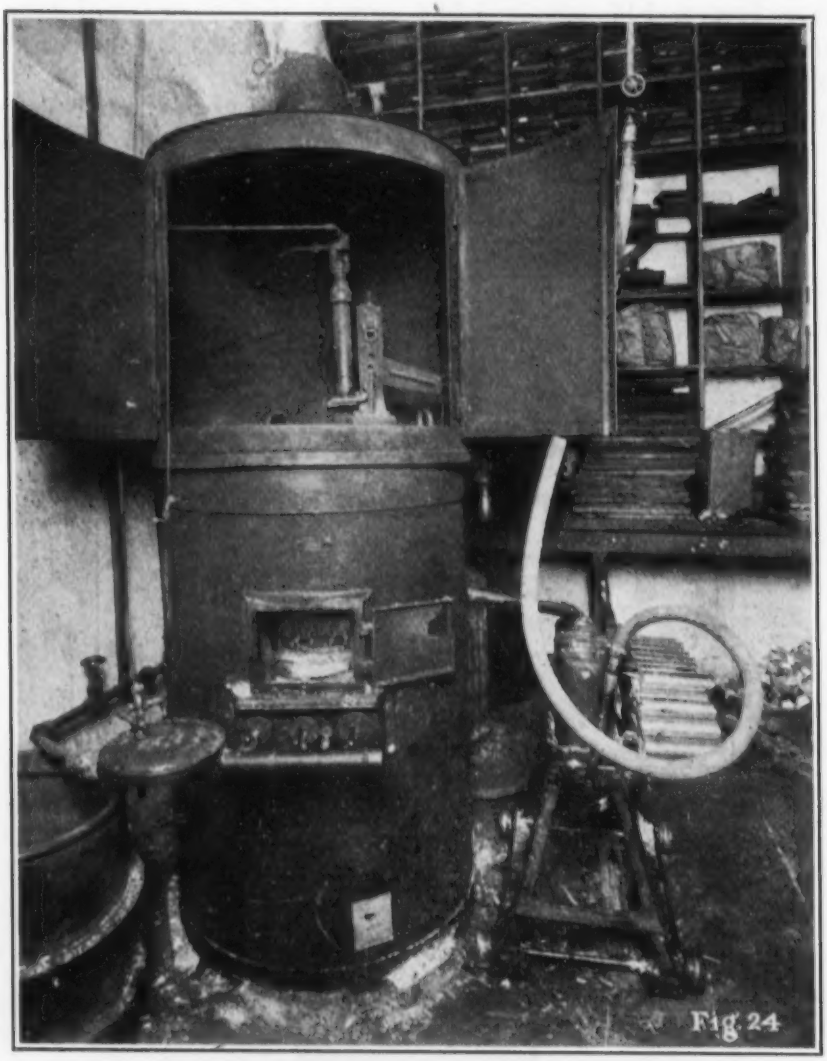


Fig. 24—Soft Metal Melting Furnace with Automatic Temperature Control

sign and construction of atmospheric type gas burners would not be amiss at this particular time.

Professor Bunsen of the University of Heidelberg noticed that when a draft of air strikes the surface of an open gas flame, the flame is reduced in size and becomes non-luminous; this suggested to him the idea of premixing a portion of the required air before combustion took place. The result of this was the reduction of the size of the flame and radiation losses due to the elimination of free carbon from the flame. Thus an increase in flame temperature resulted, and it is upon this last condition that the value of atmospheric burners depends for useful work, as a high flame temperature means a higher temperature in the products of combustion. It is important that high flame temperature be maintained for most industrial purposes.

In the design of an ordinary pipe burner, the first thing to know is the amount of gas you desire to burn so as to select the proper size pipe. The gas burning capacities of pipes are as follows:

Size of pipe:	⅜-in.	½-in.	¾-in.	1-in.	1¼-in.	1½-in.	2-in.
Cubic feet per hour	1-15,	5-25,	15-40,	25-60,	40-90,	60-140,	80-230.

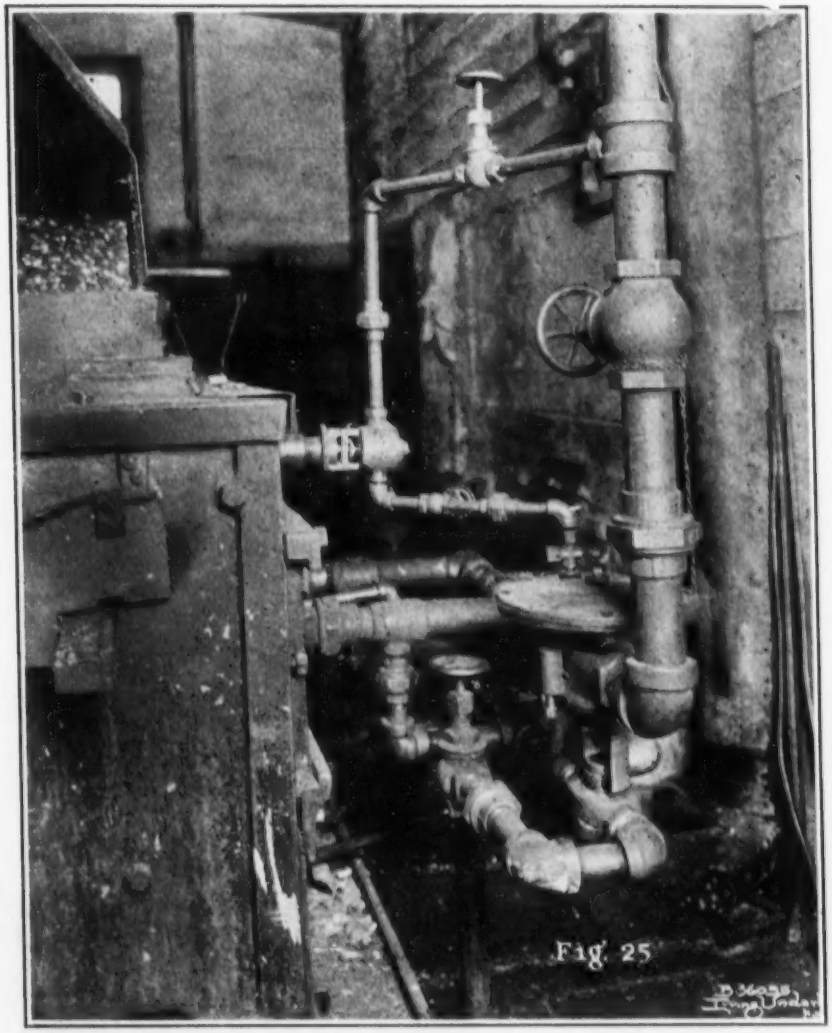


Fig. 25—Thermostatic Temperature Control for Blast Burners

The next thing to know is the length of the flame along the pipe. It has been found by experimentation that the proper spacing of the burner ports of the average burner should be one-third inch center to center. Now to find the number of ports, multiply the length of the flame by 3 and add 1 for the first port. Then to find the diameter of the drilled port, we note in the standard table of properties of wrought iron pipe, the internal area of the size pipe we have selected. From this figure should be deducted an allowance of 5 to 10 per cent to compensate for contraction or flow through small openings. The remainder divided by the number of ports will give us the area of each port.

Care should be taken to see that the first port is spaced not less than five times the diameter of the pipe, from the air mixer. This gives the air and gas a good chance to mix thoroughly before reaching the first port.

As to the size of gas orifice in the air mixer, this is obtained by reference to the standard table of drill sizes, diameters, circumferences, and areas.

Adjustable Air Shutters

As to the style of air mixer to use, either the conical face type or

the flat face type is satisfactory, but the latter type is preferable in most installations. In either case they should be equipped with adjustable air shutters. In order to function properly, these mixers must be me-

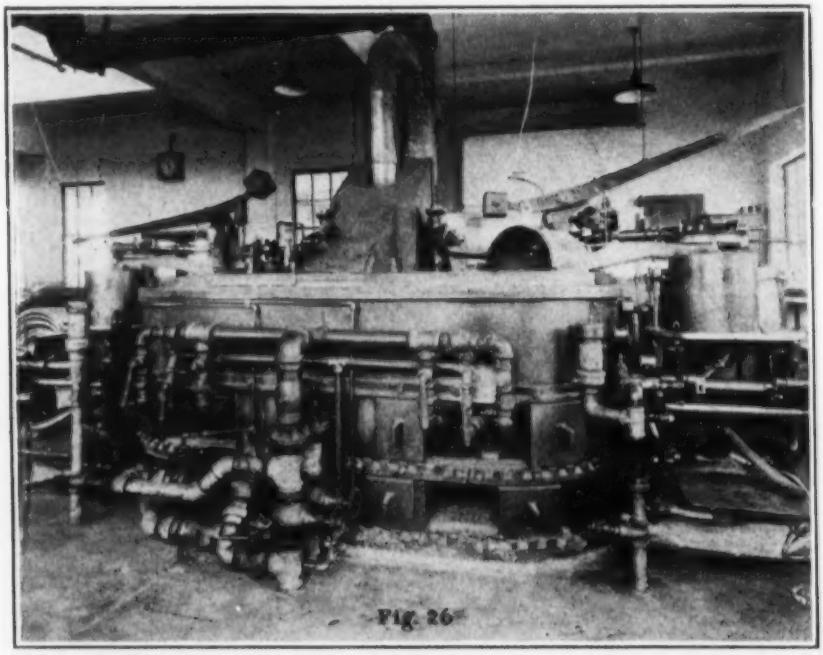


Fig. 26—Gas-fired Stereotyping Pot for Large Newspaper Offices

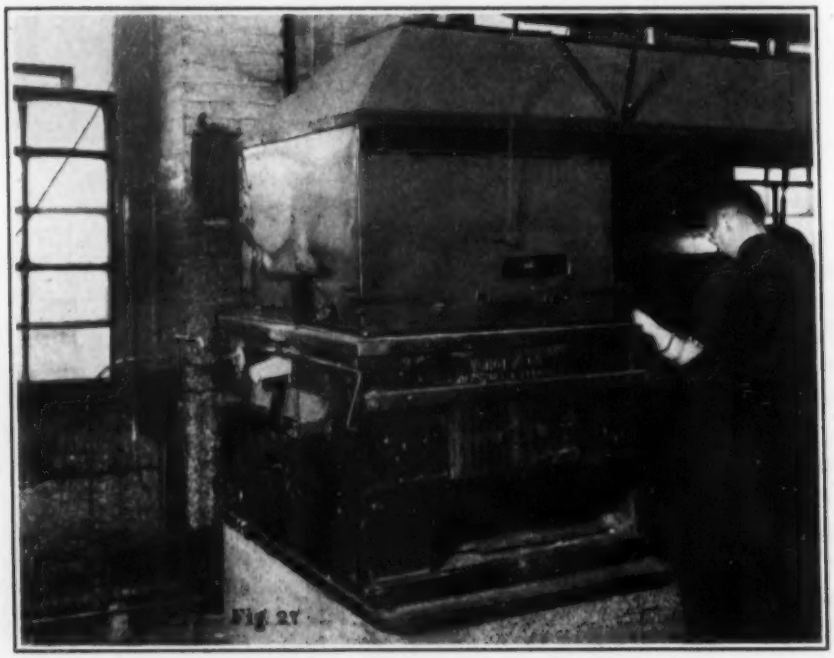


Fig. 27—Thermostatically Controlled Dross Melting Furnace

chanically perfect. It is therefore advisable to apply to your gas company for them where they are carried in stock.

The effect of using a pipe too small will be yellow and higher flames

Fig. 29—Gas-fired Water Still for Laboratory Purposes

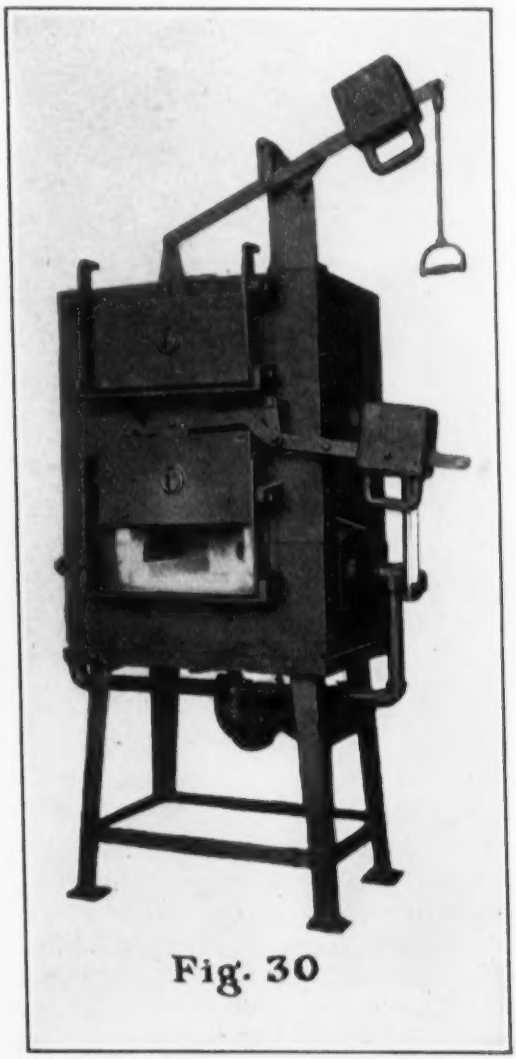


Fig. 30—Combination High-Speed Steel Heating Furnace with Pre-heater

especially at the rear end of the burner. On the other hand a pipe too large will produce flames that are small, round, and lifeless with very little heating value. In either case the efficiency is low. Fig. 9 shows pipe burner with proper length of mixing tube.

If the mixing tube (that part from the air mixer to the first port) is too short, (Fig. 10) the flames will be uneven and will hardly burn at the first few ports. Oftentimes it is impossible to prevent a back-fire.

If the mixing tube is too long, it will cause the gas to have a tendency to back out through the air shutters, and the flames at the burner ports will be yellow.

Under no circumstances should there be a bend or obstruction in the mixing tube.

The orifice in the air mixer must be exactly centered so as to give an even suction on the air. Otherwise a lazy, lifeless, yellow tipped flame will result.

If the burner ports are spaced too close, this will cause the flames

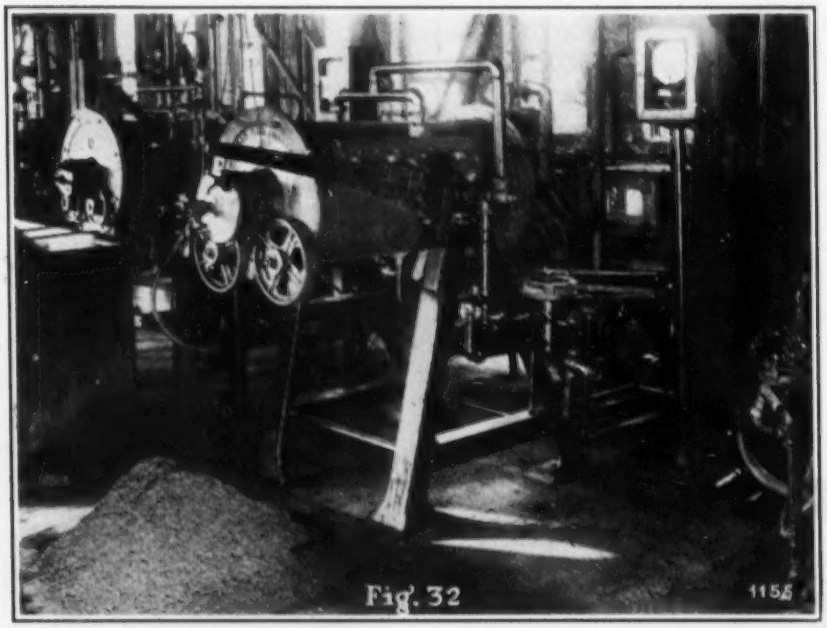


Fig. 32—Rotary Carburizing Furnaces Gas-fired. This Machine is Capable of Treating 75 Pounds of Screw Pins per Charge

to have a tendency to run together and smother, whereas, if they are spaced too far apart the flames will not catch readily and an explosion may result.

For drawing the temper of steel there is nothing better than an oil tempering bath, especially when the temperature is controlled by an automatic thermostat. As the maximum temperature desired is 600 degrees Fahr., the bath heated by gas is preferable owing to the ease of control. There are many efficient gas fired oil tempering furnaces on the market and several automatic temperature controllers.

Gas fired brazing tables shown in Figs. 18, 20 and 22, have a wider range of usefulness than any other heating appliance. By the aid of fire brick it may be readily converted into a forge or furnace for tool dressing, forming, bending, etc. The tables have many other uses, such as annealing brass or copper, sweating solder, heating rivets, and pre-heating for acetylene welding.

Next to the brazing table, the handiest gas appliance for heating operations is the gas-electric torch. This torch is a portable, self-contained unit consisting of a small electric motor blower with gas connection and burner nozzle. It is very light, weighing only a few pounds. Current for the motor is obtained from any electric light socket, and gas connection is made by means of a rubber hose. It is instantly adjusted to any position or angle and can be carried anywhere in one hand. Temperatures as high as 2500 degrees Fahr. are easily obtained with this torch. Its uses are many and varied, among them being the heating of ladles, the heating of an improvised furnace, for aluminum melting and soldering, for pre-heating in acetylene welding, and heating for bending, forming and straightening operations.

There are on the market today well designed and efficient furnaces which are gas fired, for tinning purposes and for soft metal melting of

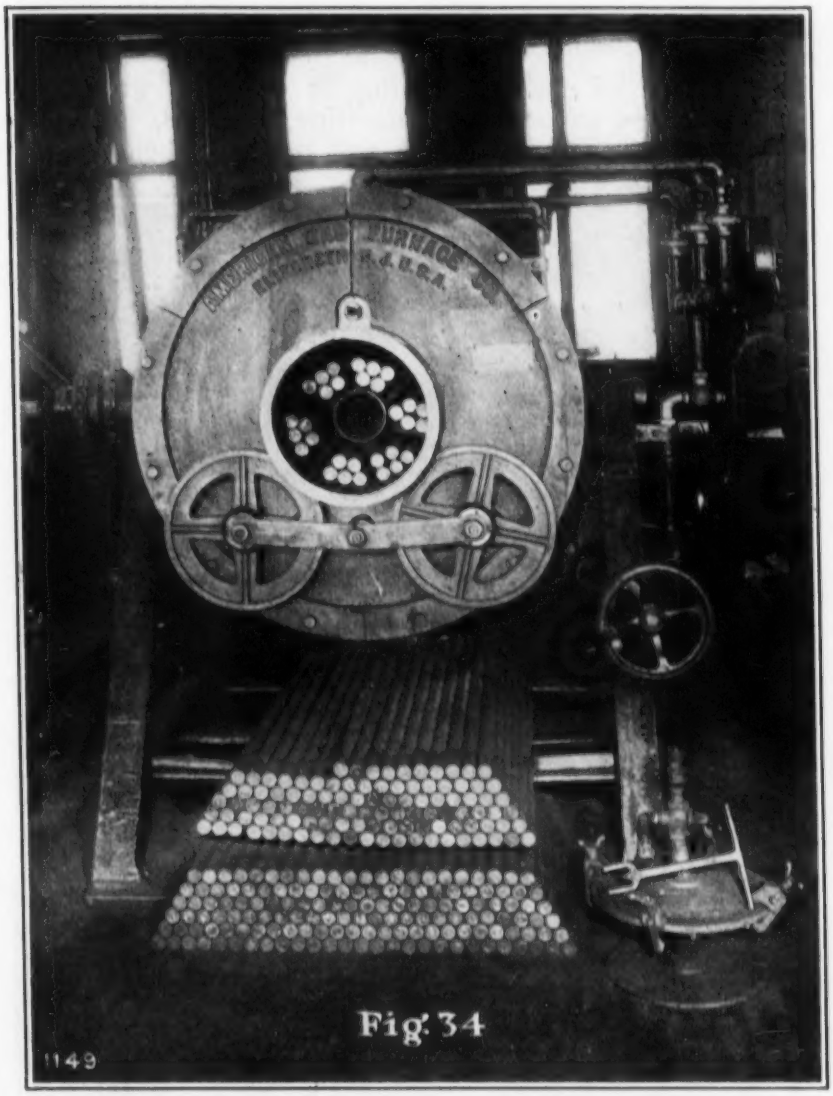


Fig. 34—Rotary Carburizing Furnace Showing Mine Car Axles in Furnace

all kinds. Fig. 24. A very considerable saving in metal is obtained by the use of automatic temperature controllers.

The oxy-acetylene torch is now almost universally used for welding and cutting, but it would be well to remember that city gas and oxygen can be and are used for cutting operations at about one-tenth the cost of oxygen and acetylene gas. The oxy-city gas torch has also been used successfully in certain welding operations of a limited nature. For lead burning purposes it is not excelled or even equaled.

Every well equipped laboratory requires pure distilled water. This is easily and quickly obtained from an automatic gas fired water still. These stills are supplied in capacities of one-half to ten gallons per hour. They are substantially and durably constructed and produce chemically pure distilled water since the steam is condensed in a tin lined copper tube. No revenue license is required as they cannot be used to distill spirits.

As to the heat treatment of high-speed steels, there are many designs of furnaces for different fuels in this work, but the writer is con-

fident that the results obtained with the combination gas furnace cannot be surpassed.

For the purpose of case hardening in quantity production, the use of the rotary gas fired carbonizing machine, Fig. 38, is most successful. This machine has a slowly revolving and properly heated cylindrical re-

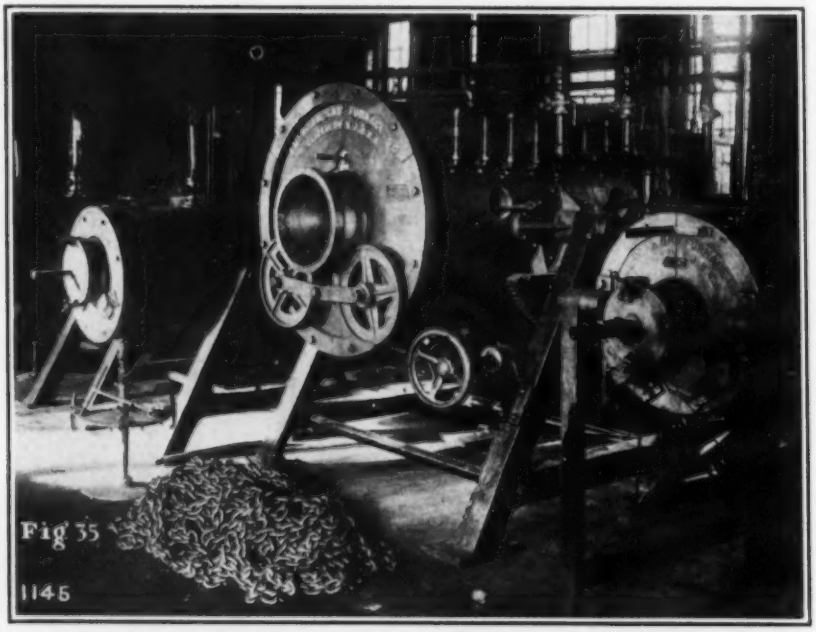


Fig. 35—Gas-fired Rotary Carburizing Furnace for Carburizing Chain

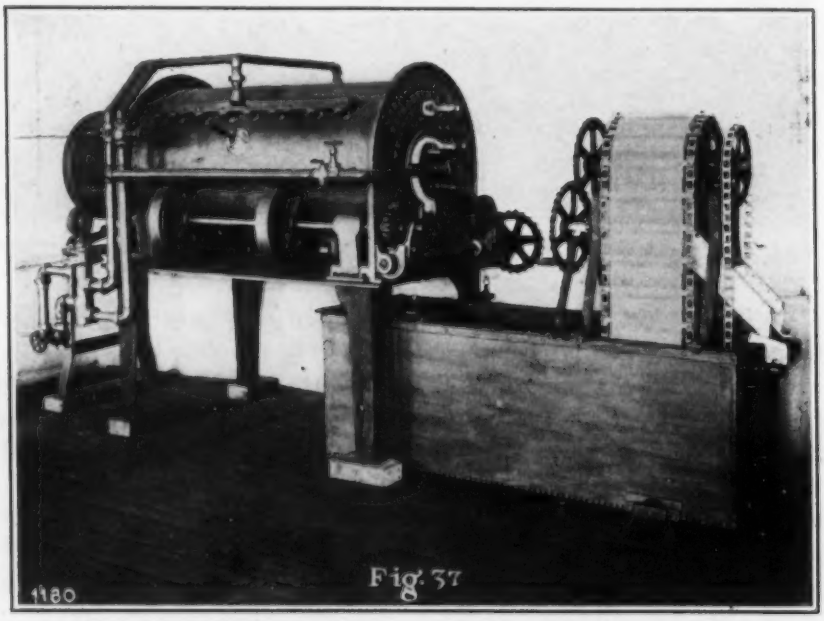


Fig. 37—Rotary Heating Furnace with Automatic Quenching Tank

tort which contains the work to be carburized. Originally city gas was injected into the retort under pressure, but a later method and more generally used is that of placing a small quantity of compound into the retort with the work. The heat rapidly converts this compound into gas and a pressure of about 65 pounds to the square inch is produced. These

machines are the fastest method of case hardening.

For heating operations such as blueing, tempering, and annealing in quantity production, the gas fired rotary heating machine is very desirable. Several types of heating, annealing and tempering furnaces are shown in Figs. 13, 35 and 37. These machines can also be fur-

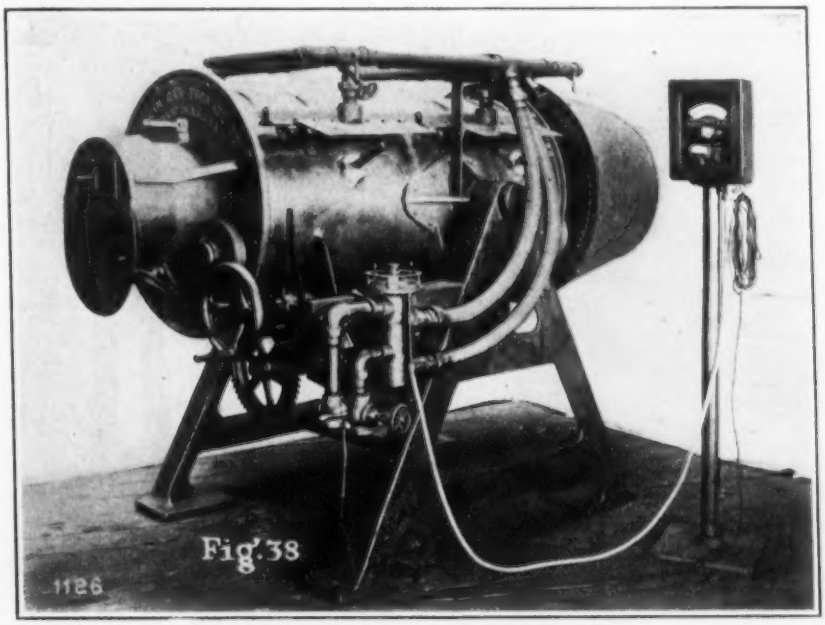


Fig. 38—Gas-fired Rotary Carburizing Machine

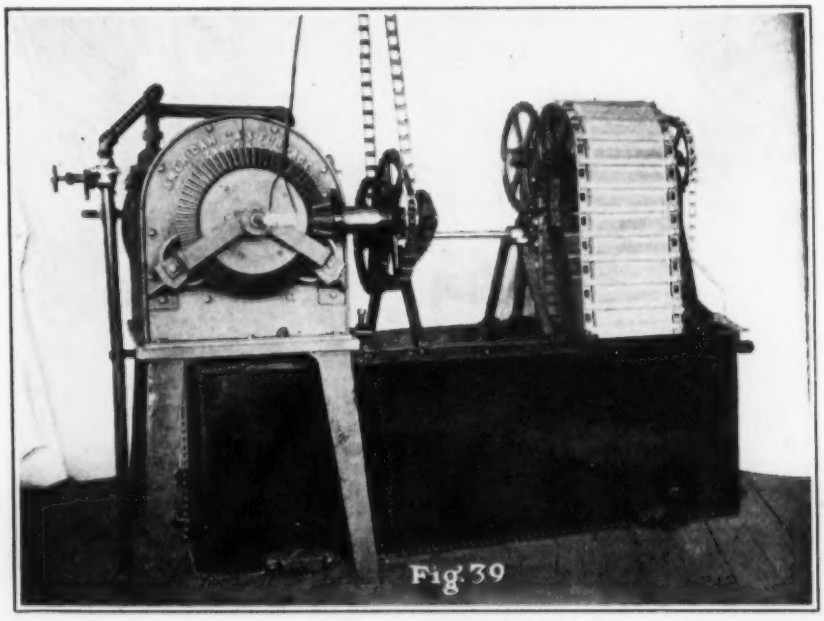


Fig. 39—Rotary Hardening Machine Equipped with Automatic Quenching Device

nished with automatic quenching tanks for straight hardening, Fig. 39.

One of the most efficient gas burners today is that with which temperatures up to 1800 degrees Fahr. may be obtained (Fig. 41 and 42) without the use of a blower. The secret of success of this burner is the patented orifice which maintains the highest possible velocity at the

Fig. 41—Small Bench Furnace for Temperatures up to 1800 Degrees Fahr. No Blower Required

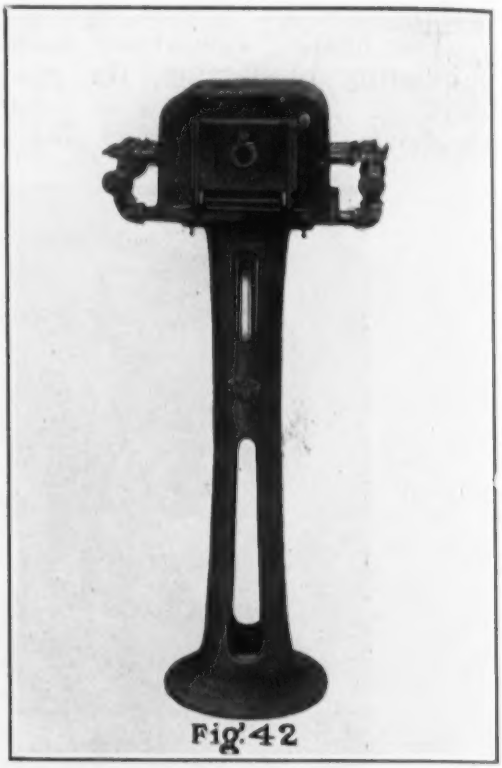


Fig. 42—Small Furnace for Temperatures up to 1800 Degrees Fahr. No Blower Required

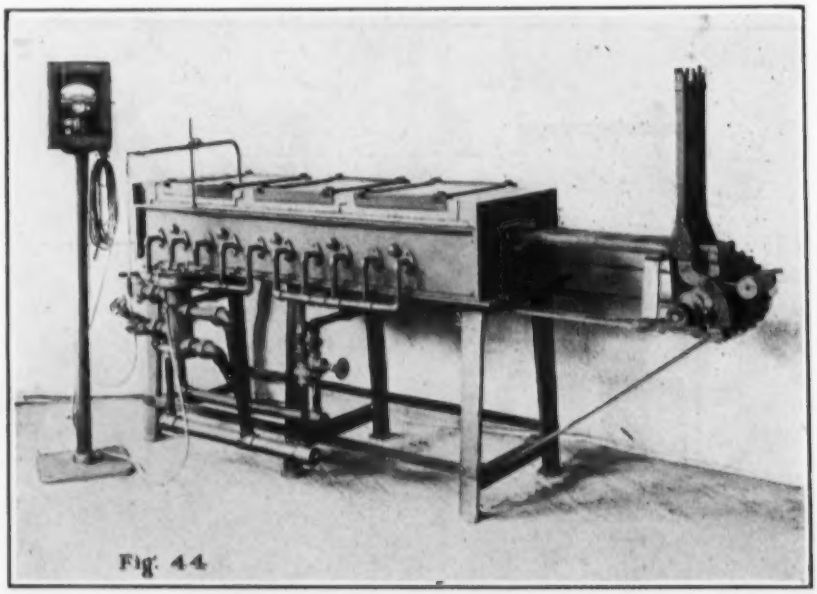


Fig. 44—Gas-fired Heating Furnace for Hardening Magnets

nozzle, directing the jet in correct alignment with the bunsen tube, and is instantly adjustable without departing from the direct jet principles.

It has been the author's observation that usually the millwright and plumber have no definite information or data but simply guess as to sizes of pipe, capacities, etc. This information is always available at the gas company, and their engineers are always ready to furnish any information or data that may be desired.

SOME FUNDAMENTALS OF RESEARCH

By F. O. Clements

Abstract

The fundamentals of industrial research are reviewed in this paper. It is pointed out that industry passes through several distinct cycles from its institution through its normal life and finally its decay. The life cycle can be prolonged indefinitely with properly directed and executed research yielding concrete results.

Research can be divided into three types. First—that of pure science, similar to the pure science research in the universities, which is concerned with the establishment of principles and fundamentals; second, finding the use for a fundamental fact is likewise research or duplicating the results of such researches can be termed commercial development; third, manufacturing developments are research activities involving new processes, new materials and frequently revolutionary methods of manufacture.

A general lack of knowledge of the problems involved in manufacturing is evidenced by the vast number of patents dealing with new inventions, most of which are valueless. Many are thoroughly practical devices, but entirely too complicated and costly to warrant utility value.

Prejudices of an investigator frequently hamper and influence his work to the detriment of the research. The author points out that an initial lack of knowledge of the problem under investigation is frequently an asset, as the investigator is then free from bias or first impressions and prejudice.

Industry Must Adapt Itself to Times

"INDUSTRY, in its simplest conception, is merely the transforming process, whereby natural resources are modified through a series of operations into commodities required to satisfy the needs of the community."

Industries, like the men who create them, have a life cycle: birth, period of development and growth, maximum power and decadence. The life cycle can be prolonged indefinitely if the industry has continuous growth through the acquisition, development and application of new knowledge. As we look back through history, we can see the working of natural law and, with this perspective can see that industry, just like the individual, must make adjustments to changes entirely outside of itself. Both men and industries fail because they have not been educated to identify or make use of facts.

Broadly speaking, the progress that has been made up to the present time, has been due to developments that are largely the outgrowth of necessity and invention. As in the case of the lumberman's forest, the finest and most accessible timber has been cut, for it was obviously worth while. The time has arrived when developments, garnered from every-day necessity and simple observation, no longer make progress. Failure to make adaptation

A paper presented at the Detroit convention, Research Symposium. The author, F. O. Clements, director of division of research, General Motors Research Corp., Dayton, O.

to the new developments perpetuates the lack of harmony, which, in time costs the industry its life. There is no standing still in the business world today.

Industry's Foundation Must Be Facts

Industry has become highly technical and complicated. It has assumed a bigness and a character that is endeavoring to change that cycle of growth, maximum power and decadence. To do this, a look into the vague future is necessary. Development and investigation along scientific lines offers a worth-while likelihood of procuring facts; and it is on the foundation of facts and not guesses or opinions that big lasting industry must build to survive at all.

Looking Ahead: Research

This look-ahead, demanding fresh subject matter or anticipation of tomorrow's law of service, has been termed *research*. Research laboratories are established for the purposeful seeking of new knowledge and the application of scientific methods.

We normally conceive of research as being technical and far removed from the routine of business. That is true only to the extent that it applies ways, means and methods, that science has developed, to observe, experiment, measure, verify and replace guesswork and opinions with facts. This age of skilled production has brought forth outstanding qualities in the human race to organize and carry through the thousands of complicated technical operations from the raw material to the finished product, designed for the well-being and comfort of humanity.

We have, through our intensive skilled manufacture, tied up the production brains on problems of today's or tomorrow's output, which requires the utmost in concentration and ability to carry through to meet time and competition.

Investigation: Research Activity

To give adequate attention to the investigation of new materials, new methods and the determining of *whys* and *wherefores* has made it necessary to bring together here and there in the industries other groups of trained skilled personnel. These groups are not satisfied that things *are*, without finding out *why* they are and *what* they will be. They have supplemented the foundry, forge, shop, mine and field with the chemical, electrical and physical laboratories, test racks, observatories, libraries and lecture rooms. Their problem has not so much to do with the production of today but with methods of utilizing waste, preventing failure and making a better product. Their contribution has to do with a better utility at a lower cost for today, tomorrow and all time. The solution of one problem today simply opens up new channels as a means of coping adequately with the dozen problems of tomorrow.

Three Kinds of Research

Every industrial laboratory concerns itself with three kinds of research:

Pure Science, similarly to pure science in the universities, is concerned with the establishment of principles and fundamentals. The worker in pure-science activities usually does not know—at least, does not know precisely—what end he will achieve. In this connection, if it be essential for an industry to insure its future by investing in an intensive study of its

problems, it surely is equally as essential that a research laboratory should explore the unknown and maintain a commanding position well ahead of the procession. Such a look-ahead should comprehend objectives, four or five years distant. Without pure science and its accumulated results, nothing can be intelligently applied. Finding the use for a fundamental fact is also research; duplicating the result can well be termed *commercial development*. So, in every well-organized research group, there is a division where ideas are analyzed for their conformance to pure-science fundamentals, as well as for their commercial requirements and practical production. As many of the research activities involve new processes, materials and even revolutionary methods of manufacture, it is also necessary to carry through in such instances initial *manufacturing developments*. This makes certain that all difficult processes and methods have been eliminated or simplified to fit in with practical methods of production. These last two functions of a research laboratory must not be permitted to interfere with the main objective, the collection of fundamental facts.

So a research group's activities consist, after all, of getting results by just plain hard work, intelligently directed and applied. Much of research work is a failure, due to the fact that few men can vision the future and the necessity involved in a useful device. We have examined untold hundreds of patents dealing with new inventions. Only a few were considered worthy of attention at all. Many were thoroughly practical devices but entirely too complicated or costly to warrant utility value. Others had no utility at all; still others were thoroughly impractical. There is altogether too much theorizing without knowing the problems.

Research: Self-Education

The job of a research laboratory is largely one of putting salt on the tails of ideas. The ancestor of every human action is a thought. Consequently, research problems are above all human problems. Research is, after all, self-education. One takes a problem and finds after sufficient self-education in the principles involved, that the solution is extremely simple. Close contact with the work at hand is essential. No one can understand the elements of a problem at long range. Reading reports and sitting in an easy chair at the end of a telephone will not answer. Our boys house with their work and get into the thick of the fray.

Prejudice and Opinions

The two great deterrents to successful research are prejudices and opinions. The first duty of a research organization is to collect facts and only facts. Engineering became worthy of credence only when definite and exact measurements took the place of guesses and wishes. It is one of the most difficult of tasks to separate one's self from opinions. Beecroft says, "It is akin to a medical operation in which we literally amputate what has become a corporate part of our daily existence. Research really becomes a work of upsetting your past life and building a new foundation upon which to survey the future and build." Industrial history is just a record of opposition and prejudice to new ideas and new methods.

"When anaesthetics were discovered, a storm of protest arose against their use. Again the stock ideas prevailed. Pain was God-given, it was said, and any attempt to alleviate it was an effort to thwart His will.

But a Scotch physician, Doctor James Simpson, who knew something about psychology as well as medicine, after long and bitter opposition, brought the startling innovation into harmony with the prevailing system of ideas by writing a pamphlet in which he said: 'My opponents forget the twenty-first verse of the second chapter of Genesis. It is the record of the first surgical operation ever performed, and that text proves that the Maker of the universe, before he took the rib from Adam's side for the creation of Eve, caused a deep sleep to fall upon Adam.' This recognition of the way in which the human mind acts won the day for anaesthetics.[1]"

When Ericsson asked for an appropriation to build the MONITOR; Fox, assistant secretary of the navy, and the naval board, condemned the idea. They said that the heavy armor would sink the vessel. Their opinions were organized and filed away. They would not even test them with arithmetic, as Lincoln wished them to do.

Morse spent 12 years during which, with his mind absorbed in one idea and yet wholly dependent for bread upon his profession as an artist, it was impossible to pursue art with the enthusiasm and industry essential to success. He was looked upon as an unforunate dreamer with a scientific toy, the electric telegraph.

Even the introduction of the telephone meant breaking through a firm wall of conservatism and opposition. Some were dubious as to its practicability. Others predicated a very limited market. When, in a group of men representing financial interests called together for interesting capital in the manufacture and sale of the invention, one impetuous youth of fifty, with the fire of vision in his eyes, smote the mahogany table and exclaimed: "Gentlemen, I can see the day when there will be 100,000 of these instruments in use in this country," his words caused consternation. "For God's sake, man," some one whispered, looking around to make sure that the door was closed. "Don't ever let that remark get outside these four walls. People will think us crazy." Today there are something like 12,000,000 telephones in use.

The bowmen of the Middle Ages resisted the introduction of the musket; the sedan-chair carriers would not allow hackney carriages to be used; the stage-coach lines attempted by all possible devices to block the advance of the railway; Arkwright, the inventor of the spinning-frame, was denounced as the enemy of the working-classes and his mill destroyed. So we could continue to narrate indefinitely. Today, we still have with us, just as strong as ever, the universal, apparently natural, prejudice against anything and everything radically different or new.

The Problem and Success

The most difficult of all questions in research is the selection of the task and the enlisting of proper co-operative effort, so that the whole organization may act effectively until the problem is solved. Good judgment in selecting the problems is paramount. Then, if the organization has men who are imbued with perseverence and enthusiasm, the result is certain. In many laboratories, failure is ofttimes caused by misdirected effort. One very large organization once built up a laboratory of considerable proportions without recognizing the limitations of their materials. They spent much money and time on a certain development without recognizing the fact that

1. Swift: Psychology and the Day's Work.

the material of which it was made was brittle when subjected to the cold, although quite ductile when hot; and yet the device was highly stressed and was to operate in both hot and cold climates. Failure to recognize this point wrecked this project. In all cases, the problem should be a fundamental one and the objective should be clearly visioned, although the way may be hidden and in doubt.

Initial Lack of Knowledge an Asset

Contrary to first impressions, ignorance of a problem is ofttimes an asset, instead of a detriment. In selecting our personnel, preference is always given to the man of sound judgment, without question intellectually honest, who will persevere until the very end. For a definite development, we often select a man totally ignorant of the subject under consideration. We consider his ignorance in that particular direction as a worthy adjunct of marked value. Why such an attitude? Because so many men, with ever so slight a knowledge of the subject, have prejudices so deeply founded that they are inclined to jump at conclusions and pronounce a certain desired end as being unattainable.

A man to avoid for research is a man with fixed opinions. A problem must be approached with an open mind or it will never meet with proper solution. No matter how able the mind, a man who will not work with others wholeheartedly retards progress and does more harm than good to any organization. All organizations have such men and they sometimes are most valuable; but usually for the most effective work they must be segregated from the balance of the organization and allowed to work alone.

Most of our engineers have had exceptional experience in industry. Men trained in practical production are of real value to a research organization, as they can see many by-products of research, particularly the pure science type, that in some instances have been of greater importance than the original objective.

It is desirable, yes necessary, to believe in a research man to the uttermost and to surround him with everything within one's power to foster his enthusiasm; for men never measure up to their best unless you manifest your confidence in them. Research activities must not be surrounded by red tape or hindrances that injure or destroy initiative and enthusiasm.

It is well to remember that the worth-while inventions that are permanent assets to civilization are the results of exhaustive work and not a flash out of the sky. The electric light was perfected only after years of close work. Over 6000 different vegetable growths were tested in order to find a suitable substance for the filament inside the glass tube. When Edison finally did finish the incandescent lamp, nobody would have it. They were afraid of it.

Typical Example of Research Development

A typical example of how research development is handled would be of interest, particularly as it shows that, after all, research as it is carried on today is a part of the every-day activity of industry, to build new or better products for tomorrow. Assume that the problem is to design a more satisfactory mechanical device than one already existing.

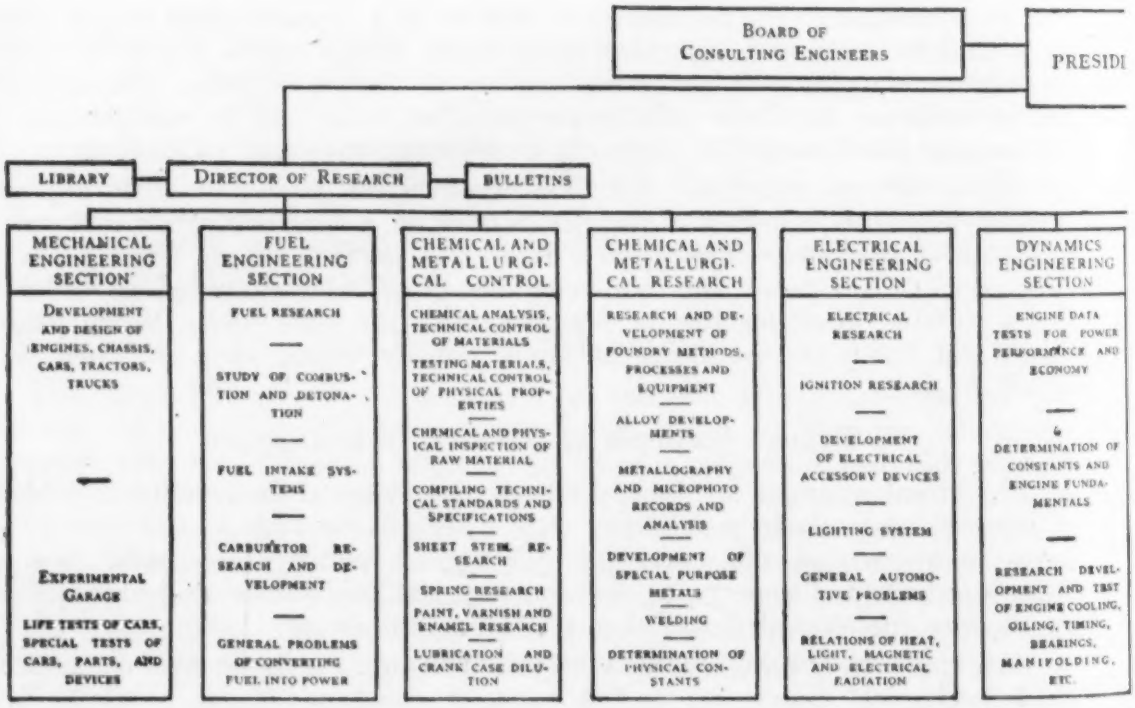
An engineer is assigned to this particular job. He is an average man of good mechanical experience and a fund of common sense. While willing

to work hard, he assumes the obligation with many misgivings, due to his ignorance of the device and its uses. Facilities, including the customary equipment of a laboratory, are given him. The research library immediately begins to comb the literature for items of interest in connection with the device or a similar utility and the patent department investigates the condition of the prior art, so that no effort will be misplaced.

The engineer's education on that particular problem begins. Possibly several similar devices, more or less satisfactory, are on the market. These are purchased and operated. Much observation follows, with definite recording of all experiments and facts. During this time, a species of specification is written visioning the objective to be reached. A picture of an ideal device, perhaps highly theoretical, is thus placed before the mind. Visioning the ideal is of great importance; for thoughts precede results.

The mechanisms are then subjected to mechanical analysis to determine efficiency. They are torn down, roughly sketched and measured for accuracy and named as to function. Assembly is made of the various components and a recheck made of the mechanical analysis to be certain that the assembly itself is correct and that the previous analysis was correct. The devices are again operated and very thorough data accumulated. Up to this time, not a single minute has been spent in designing the new equipment necessary to meet the ideal; in fact, little money has been spent and all of that for education. The result is that we have a man in charge of the work who has a very thorough knowledge of the fundamentals that pertain to that particular job.

Progress reports have been filed and, as a result, the laboratory possesses a volume or two that give definite facts. In this connection, the definite recording of failures or negative results are just as important as the recording of successes. Without much delay, the problem blossoms into the design stage. There has been no 'hit and miss' or wishbone type of design,


BOARD OF CONSULTING ENGINEERS
PRESIDI
LIBRARY
DIRECTOR OF RESEARCH
BULLETINS
MECHANICAL ENGINEERING SECTION
DEVELOPMENT AND DESIGN OF ENGINES, CHASSIS, CARS, TRACTORS, TRUCKS
EXPERIMENTAL GARAGE
LIFE TESTS OF CARS, SPECIAL TESTS OF CARS, PARTS, AND DEVICES
FUEL ENGINEERING SECTION
FUEL RESEARCH
STUDY OF COMBUSTION AND DETONATION
FUEL INTAKE SYSTEMS
CARBURETOR RESEARCH AND DEVELOPMENT
GENERAL PROBLEMS OF CONVERTING FUEL INTO POWER
CHEMICAL AND METALLURGICAL CONTROL
CHEMICAL ANALYSIS, TECHNICAL CONTROL OF MATERIALS
TESTING MATERIALS, TECHNICAL CONTROL OF PHYSICAL PROPERTIES
CHEMICAL AND PHYSICAL INSPECTION OF RAW MATERIAL
COMPILING TECHNICAL STANDARDS AND SPECIFICATIONS
SHEET STEEL RESEARCH
SPRING RESEARCH
PAINT, VARNISH AND ENAMEL RESEARCH
LUBRICATION AND CRANK CASE DILUTION
CHEMICAL AND METALLURGICAL RESEARCH
RESEARCH AND DEVELOPMENT OF FOUNDRY METHODS, PROCESSES AND EQUIPMENT
ALLOY DEVELOPMENTS
METALLOGRAPHY AND MICROPHOTO RECORDS AND ANALYSIS
DEVELOPMENT OF SPECIAL PURPOSE METALS
WELDING
DETERMINATION OF PHYSICAL CONSTANTS
ELECTRICAL ENGINEERING SECTION
ELECTRICAL RESEARCH
IGNITION RESEARCH
DEVELOPMENT OF ELECTRICAL ACCESSORY DEVICES
LIGHTING SYSTEM
GENERAL AUTOMOTIVE PROBLEMS
RELATIONS OF HEAT, LIGHT, MAGNETIC AND ELECTRICAL RADIATION
DYNAMICS ENGINEERING SECTION
ENGINE DATA TESTS FOR POWER PERFORMANCE AND ECONOMY
DETERMINATION OF CONSTANTS AND ENGINE FUNDAMENTALS
RESEARCH DEVELOPMENT AND TEST OF ENGINE COOLING, OILING, TIMING, BEARINGS, MANIFOLDING, ETC.

which too often interferes with effective and economical work. The mechanical analysis showed the losses in order of importance. Thus the research engineer has established yardsticks from which to measure conclusions and he knows where to concentrate effort.

Our experience has been that the most difficult part of any development is to understand clearly the problem ahead; in fact, one of the axioms of our organization is *a problem thoroughly understood is always fairly simple.*

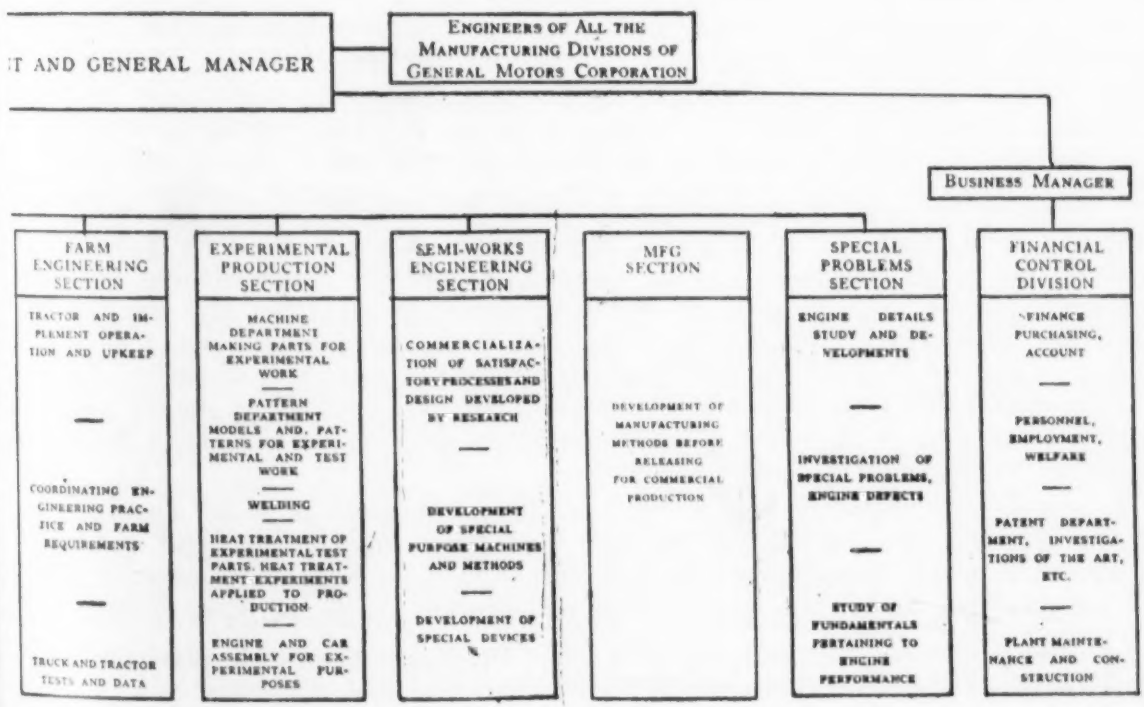
Scientific research must be untrammeled and free from restraint. The laboratory budget should always include an allowance to permit immediate tryout of new ideas that seem to have promise. If, with tinsnip-soldering-iron-methods, the worth of the idea is demonstrated, the work can then be accepted as a major project and a definite appropriation provided. For a new project to assume major importance, its merit and utility must be proved unqualifiedly by analysis and it must represent a real need of the world from the standpoint of either a new, lower-priced or better product.

Definite Standards

It is customary with us not only to vision the ideal but also to set a price to be met in production and establish a yardstick of what performance should be. It is always well to design with a high degree of quality in mind. If the price bogie will not permit such an expenditure, it then becomes necessary to study the offending detail intensively, so as to lower the cost and still retain the quality. These three things are of very great importance and must be clearly recognized prior to expending effort and time on the initial design. They sound trite but really furnish the compass that not only steers the investigation in hand to a successful outcome but largely determines the growth of the organization as a research staff worth while.

Definite organization, detailing problems and functions, is necessary, of

(*Concluded on Page 429*)


T AND GENERAL MANAGER
ENGINEERS OF ALL THE MANUFACTURING DIVISIONS OF GENERAL MOTORS CORPORATION
BUSINESS MANAGER
FARM ENGINEERING SECTION
TRACTOR AND IMPLEMENT OPERATION AND UPKEEP
COORDINATING ENGINEERING PRACTICE AND FARM REQUIREMENTS
TRUCK AND TRACTOR TESTS AND DATA
EXPERIMENTAL PRODUCTION SECTION
MACHINE DEPARTMENT MAKING PARTS FOR EXPERIMENTAL WORK
PATTERN DEPARTMENT MODELS AND PATTERNS FOR EXPERIMENTAL AND TEST WORK
WELDING
HEAT TREATMENT OF EXPERIMENTAL TEST PARTS. HEAT TREATMENT EXPERIMENTS APPLIED TO PRODUCTION
ENGINE AND CAR ASSEMBLY FOR EXPERIMENTAL PURPOSES
SEMI-WORKS ENGINEERING SECTION
COMMERCIALIZATION OF SATISFACTORY PROCESSES AND DESIGN DEVELOPED BY RESEARCH
DEVELOPMENT OF SPECIAL PURPOSE MACHINES AND METHODS
DEVELOPMENT OF SPECIAL DEVICES
MFG SECTION
DEVELOPMENT OF MANUFACTURING METHODS BEFORE RELEASING FOR COMMERCIAL PRODUCTION
SPECIAL PROBLEMS SECTION
ENGINE DETAILS STUDY AND DEVELOPMENTS
INVESTIGATION OF SPECIAL PROBLEMS, ENGINE DEFECTS
STUDY OF FUNDAMENTALS PERTAINING TO ENGINE PERFORMANCE
FINANCIAL CONTROL DIVISION
FINANCE PURCHASING, ACCOUNT
PERSONNEL, EMPLOYMENT, WELFARE
PATENT DEPARTMENT, INVESTIGATIONS OF THE ART, ETC.
PLANT MAINTENANCE AND CONSTRUCTION

THE HEAT TREATMENT OF CAST STEEL FOR HYDROELECTRIC POWER MACHINERY

By B. Egeberg

Abstract

Norway is one of the foremost countries in hydroelectric power development. They have become experienced in the production of machinery for this purpose which will stand up under the conditions of operation which are required of it.

The author outlines the specifications usually used in ordering steel castings for hydroelectric power making. These specifications include the chemical composition, physical properties and thermal treatment. It is pointed out that the specifications are quite exacting although not too much so inasmuch as they can be complied with through proper thermal treatment when the steel is uniform in composition and sound in structure.

THIS paper dealing with the material used in hydroelectric power machinery in Norway may be of some interest, inasmuch as Norway is one of the countries which has taken a leading part in the utilization of water power.

The turbines, the pelton disks, shovels, trottle-valves, valve-housings, etc., from the smallest to the largest ever made in any country, are all made of electric cast steel. Inasmuch as the damage that a break down of any part, would produce would be tremendous, the material specifications are very strict, and usually are as follows:

Tensile strength: 60,000 to 70,000 pounds per square inch
Yield point: 34,000 pounds per square inch (not always required)
Elongation in 2 inches: minimum 30 per cent
Reduction in area: minimum 45 per cent
Charpy impact: up to 8 kilogram meters per square centimeter (with charpy pendulum small size; test bar 10 x 10 millimeters 100 millimeters long and notched as in sketch Fig. 1.)
The microscope shall show a fine, rounded grain and the carbon shall be evenly distributed. No welding of cavities and blow holes is permitted. The specifications are to be fulfilled by annealing.

Probably the required impact figure will be the difficult part of the specification. The work of 8 kilogram meters approximates 58 foot pounds and by way of comparison, a nickel chromium steel for casehardening purposes (C .13 to .15, Cr 1.00, Ni 4.00) hardened in oil from 870 degrees Cent. and tempered at 650 degrees Cent. and then cooled in oil, will give a charpy impact figure of 13 to 14 kilogram meters per square centimeter. As will be shown later, an impact toughness as high as 12 kilogram meters per square centimeter is in some cases obtained on castings, which have been subjected to the adopted heat treatment.

To obtain the required impact number, the steel must be mild (usually .18 to .22 per cent carbon) pure and free from any defects and must be poured at a low temperature; the last item is of great importance especially for big castings, as hot pouring of such will produce large dentrites causing

A paper written for TRANSACTIONS. The author Dr. Birger Egeberg, is metallurgist, the Stavanger Electro-Staalverk, Stavanger, Norway.

trouble in heat treating. A typical melt analyzed C .20, Mn. 63, P. 020, S .012, Si .25, no alloy being used. The regular cast condition is seen in Fig. 2 taken from a pelton disk weighing 6000 kilograms.

As every big casting and every set of smaller ones cast together (linked together) is to be tested by the customer's inspector, the castings are always furnished with attached coupons about 30 x 40 millimeters in section and 300 millimeters long, which are drilled or sawed off after the final heat treat-

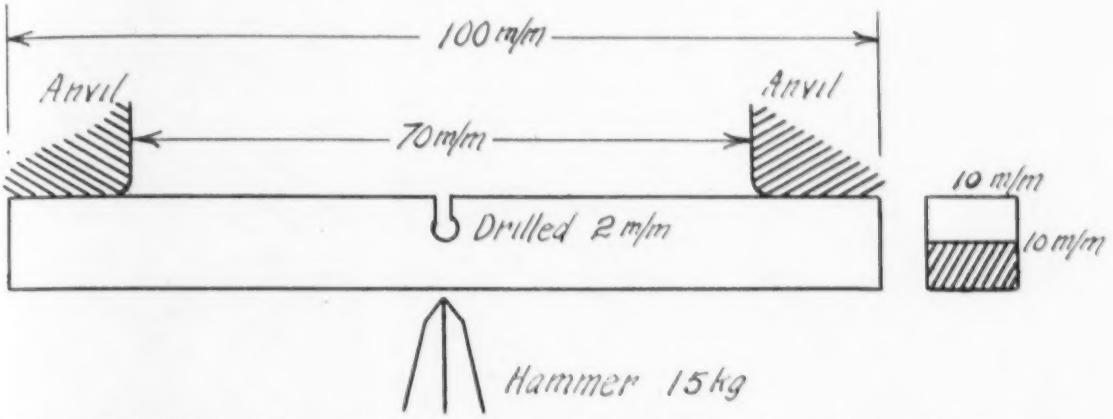


Fig. 1—Sketch of Charpy Impact Test Bar, Showing Method of Supporting and Fracturing the Specimen

ment has taken place. Additional coupons are preliminarily tested in the laboratory, so that every casting put before the inspector is sure to pass inspection. As a guide for the heat treatment to be undertaken there is produced from every melt a sufficient number of fractures which shows the grain as cast.

First Heat Treatment

Castings weighing up to 8 tons are treated in an electric annealing furnace, larger castings in an 80-ton furnace heated with producer gas. Both furnaces are controlled by pyrometric regulators. The electric furnace is very well adapted to exact working but will, like other furnaces, cool down much too slowly for the purpose, as a more rapid cooling from the annealing temperature to about 650 degrees Cent. is essential in order to meet the specifications. Opening the door gives uneven cooling, and the pulling out of the car type bottom is not to be recommended on account of the danger of warping. The castings for hydroelectric power machinery are usually of an intricate shape, and therefore liable to warp if not cooled evenly. The furnace has therefore been equipped with air inlets in the roof, connected to a strong blower having large air volume and low pressure. By this arrangement the steel can be cooled down to below the critical point Ar^1 in a comparatively short time.

The heat treatment of the larger castings in the gas-fired furnace is conducted along the same lines. The gas enters through inlets in the roof and the air through additional openings. Every gas inlet has its own air inlet. Cold air from a blower is used. The furnace is lighted with a long burning stick brought up under the roof, or through a fire lit on the car bottom. The cooling down of the castings is accomplished as in the electric furnace.

The annealing temperature is in most cases 900 degrees Cent. (1650 de-

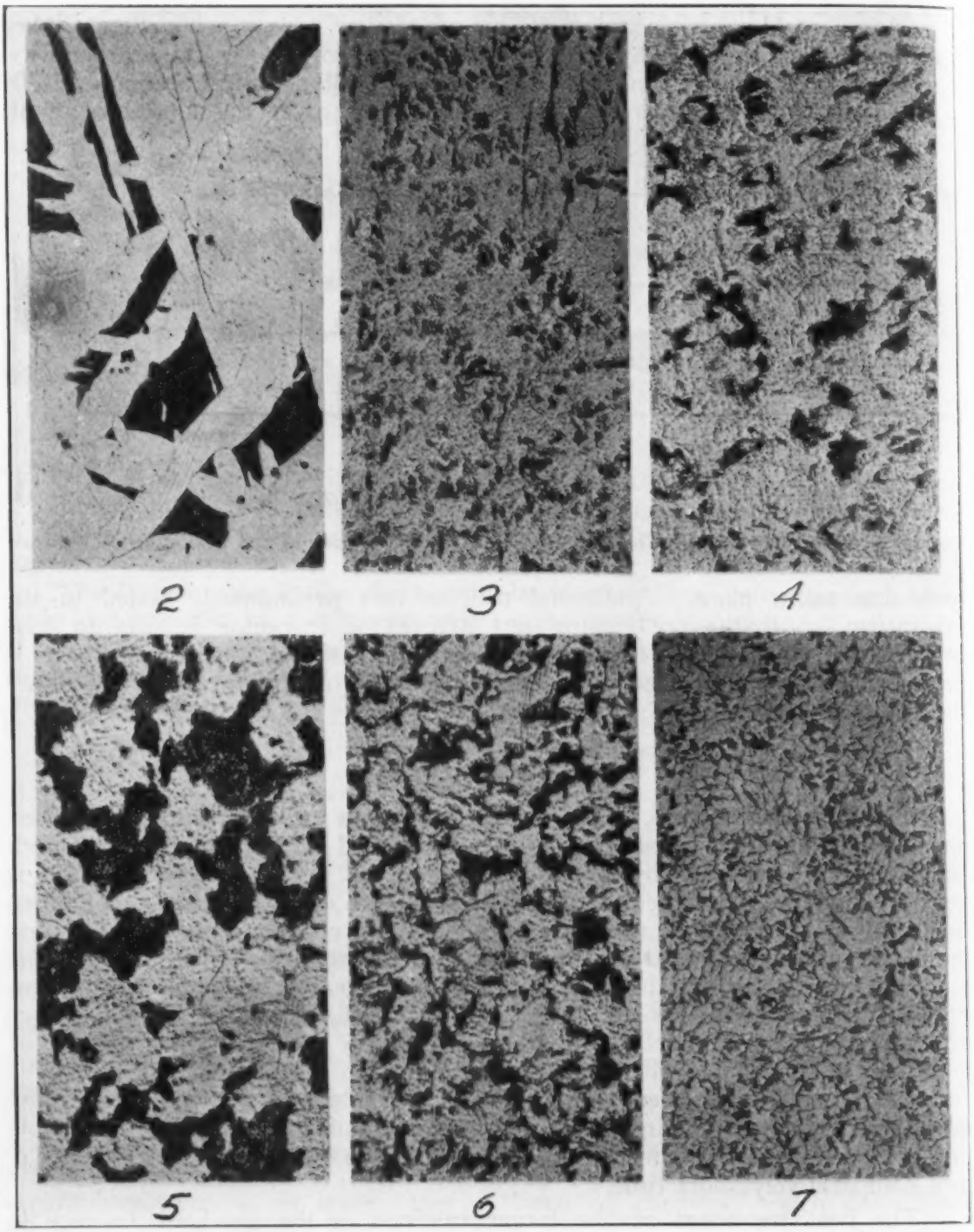


Fig. 2—Ordinary Structure of a 6-Ton Pelton Disc as Cast. Fig. 3—Structure of a 200-Kilogram Casting. It Showed a Charpy Impact of 12 Kilogram Meters per Square Centimeter. Fig. 4—Structure of an 8-Ton Casting Heat Treated Like Specimen in Fig. 3 Showed an Impact of 9 Kilograms per Square Centimeter. Fig. 5—Showing Excessive Grain Size. This Specimen Showed an Impact of 6 Kilograms per Square Centimeter. Fig. 6—Taken from a 7-Ton Casting. Fig. 7—Taken from a 200-Kilogram Casting Each Showing 9 Kilograms per Square Centimeter Impact

grees Fahr.) which temperature is held for a period of 4 to 10 hours (depending upon the size of the castings) and is then allowed to cool until black. The furnace is again raised to 650-700 degrees Cent. (1200-1290 degrees Fahr.) well below the Ac^1 point, the exact temperature depending upon the carbon and manganese content of the pieces under treatment, and held there for a period of 4 to 6 hours. The castings are then allowed to cool with the furnace. It should be noted that the given time-temperature intervals do not in all cases include the time necessary for the heat to penetrate the castings. It is quite noticeable that steel heat treated even in this mild way will become much tougher than steel cooled slowly in and with the furnace.

The object of the first treatment is:

1. To destroy ingotism
2. To impart to the steel as fine a grain as possible, because with a large grain, the required impact figure is not obtained, even where the ingotism is perfectly eliminated. The annealing temperature must therefore not materially exceed 900 degrees Cent. as the writer's experience, contrary to that of some other investigators, is that a higher temperature will influence the impact figure.

Coarse Grained Fractures Undesirable

Excluded castings where the fracture in the cast condition showed too coarse a grain, and further excluding castings weighing more than about 8 tons, the described process will give products of which about 2/3 will pass the preliminary laboratory tests. Figs. 3 and 4 respectively show the structure of a 200-kilogram and an 8-ton casting treated in this way. The casting illustrated by Fig. 3 gave an impact toughness of 12 kilogram meters per square centimeter, and the other 9 kilogram meters per square centimeter. These preliminary tested pieces are placed before the inspector or shipped with the attached coupons. The remaining 1/3 of the castings will, in most cases, fulfill the specifications excepting that of the impact figure. These are observed under the microscope in order to discover any dangerous arrangements of slag-inclusions, ingotism, etc. Fig. 4 shows the structure of a big casting which has undergone the described heat treatment, and which did not show the required impact figure, all other parts of the specifications being fulfilled, i. e.

Tensile strength	64,000 pounds per square inch
Yield point	35,000 pounds per square inch
Elongation in 2 inches	33 per cent
Reduction in area	58.8 per cent
Charpy impact	6 kilogram meters per square centimeter

The static tests are very satisfactory but the impact figure being 2 kilogram meters per square centimeter too low. The casting had to be treated once more on account of excessive grain size and slight carbon segregation, in order to obtain the necessary impact toughness. This gives an idea of the very rigid requirements which some manufacturers of hydroelectric power plant machinery are specifying. It is not the place here to discuss the value of such specifications, however it will only be mentioned that there is a tendency to go down to 6 kilogram meters per square centimeter impact figure.

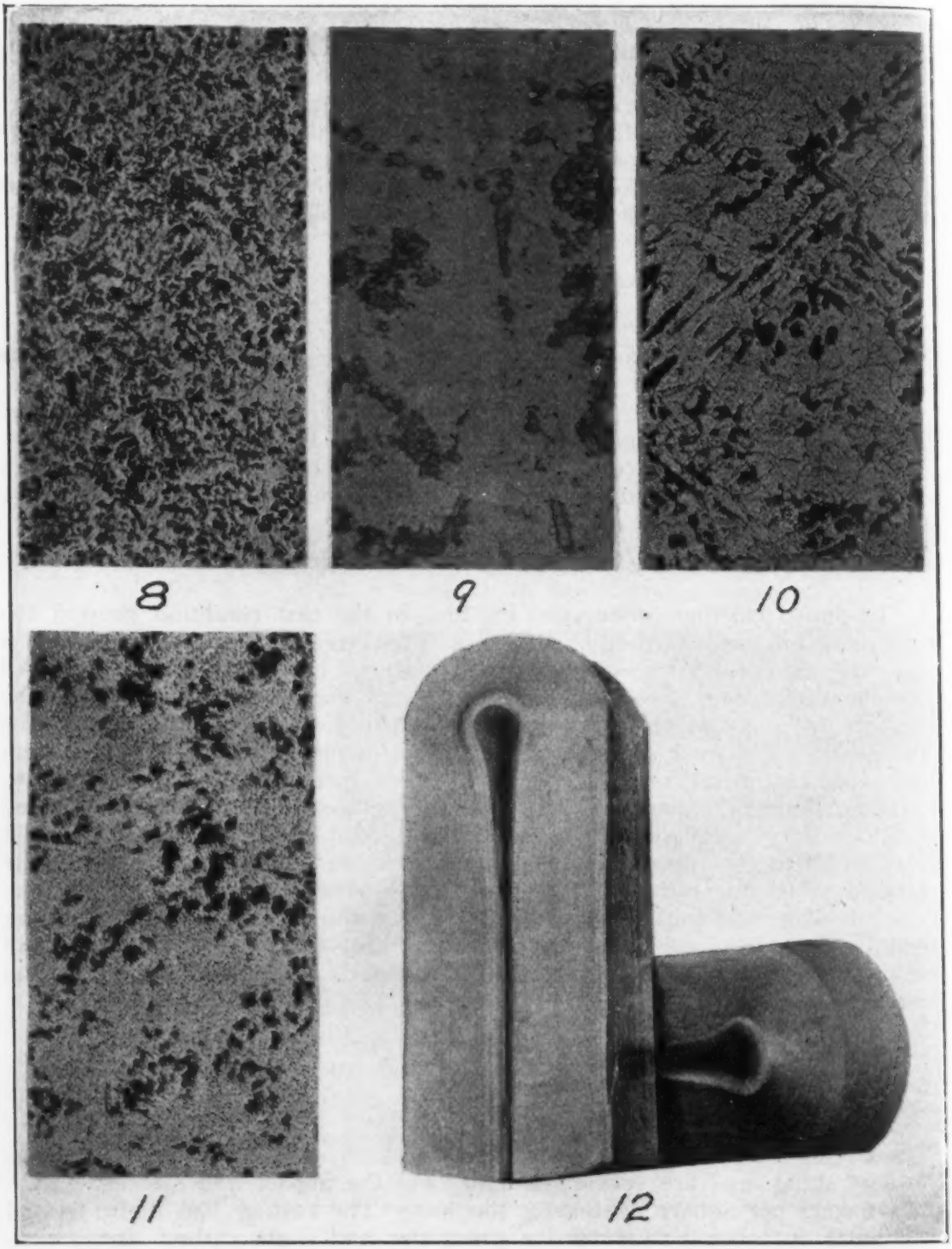


Fig. 8—Shows the Structure of a Specimen Which Showed an Impact of 3 and 5.15 Kilograms per Square Centimeter. Fig. 9 X 500—Shows Sulphide Slag Inclusions Forming Continuous Lines. Same as Fig. 8. All Specimens X 100. Fig. 10—Specimen Showing Traces of Cast Structure Which Gave an Impact of 5 Kilograms per Square Centimeter. X 100. Fig. 11—Imperfectly Annealed Specimen Showing a Charpy Impact of 8 Kilograms per Square Centimeter. X 100. Fig. 12—Bend Test Made on Specimen Fig. 11

Second Heat Treatment

The 1/3 of the castings not fulfilling the requirements but showing no other defect than excessive grain size, (Fig. 5) are heated once more for a short time to nearly 900 degrees Cent., but long enough for the heat to penetrate to the interior of the castings and refine the grain, they are then immediately cooled down to black. Then follows the low temperature treatment at 650 to 700 degrees Cent. as before. Typical photomicrographs are shown illustrating the various structures resulting from different heat treatments.

After the second treatment, if perfectly conducted, the castings will show a structure as represented by Figs. 6 and 7 taken from a large 7-ton and a small 200-kilogram casting respectively. If the steel is pure and good, it will in this condition give an impact number of 8 kilogram meters per square centimeter and more. On the other hand, if the steel is not good, no heat treatment as specified here will bring the impact toughness up to what is required. Fig. 8 shows the microstructure of such a casting weighing about 2 tons after the second heat treatment. The grain is very close and the cast structure is perfectly destroyed, so evidently the heat treater is not to be blamed for the fact that the steel showed an impact number of 3 and 5.15 kilogram meters per square centimeter. The variation in the figures indicates that something is wrong, as otherwise the results in good steels are more constant. Fig. 9 at 500 diameters magnification shows sulfide slag inclusions forming dangerous lines of weakness. This condition accounts for the low toughness and also for the variations in impact values inasmuch as these may occur depending upon whether few or many of these slag lines are present on the notched spot of the test-bar. It is noticeable that a steel with a considerable amount of finely distributed inclusions tends to a closer grain than does purer steel. Furthermore slight traces of the cast structure influences the toughness and prevents the required impact figures from being obtained. Fig. 10 shows the structure in such a steel giving 5 kilogram meters per square centimeter charpy impact figure. After the second heat treatment the figure was 8.7 kilogram meters per square centimeter and the microstructure is shown on Fig. 11, showing a peculiar arrangement of the pearlite along lines surrounding the ferrite. The same is more often to be found in higher carburized materials and is supposed to represent an intermediate state in castings not perfectly annealed. If not very pronounced it will impart to the steel satisfactory strength and toughness, the casting demonstrated by photomicrograph, Fig. 11 gave cold bend tests ¾ x 1 inch as shown in Fig. 12.

Larger castings weighing more than about 8 to 12 tons and pieces cast with an excessively coarse fracture almost always require the second heat treatment, which in these cases is undertaken at once, the first treatment being sometimes conducted on a slightly higher temperature, as the complete destroying of ingotism only is aimed at.

The program in this case will be:

1. Heat to 900-950 degrees Cent.
2. Hold at this temperature for 4 to 10 hours according to the weight and thickness of the castings and the size of the truckload.
3. Cool down till black.
4. Heat to nearly 900 degrees Cent. till the steel is heated through.

5. Blow down till black.
6. Reheat to 650 to 700 degrees Cent.
7. Hold at this temperature for 4 to 6 hours.
8. Cool down with the furnace.

In the electric oven, a casting weighing up to about 8 tons can be heat treated as nearly exact as small pieces in a laboratory furnace. Working with the gas-fired furnace this exactness is not as readily obtained, necessitat-

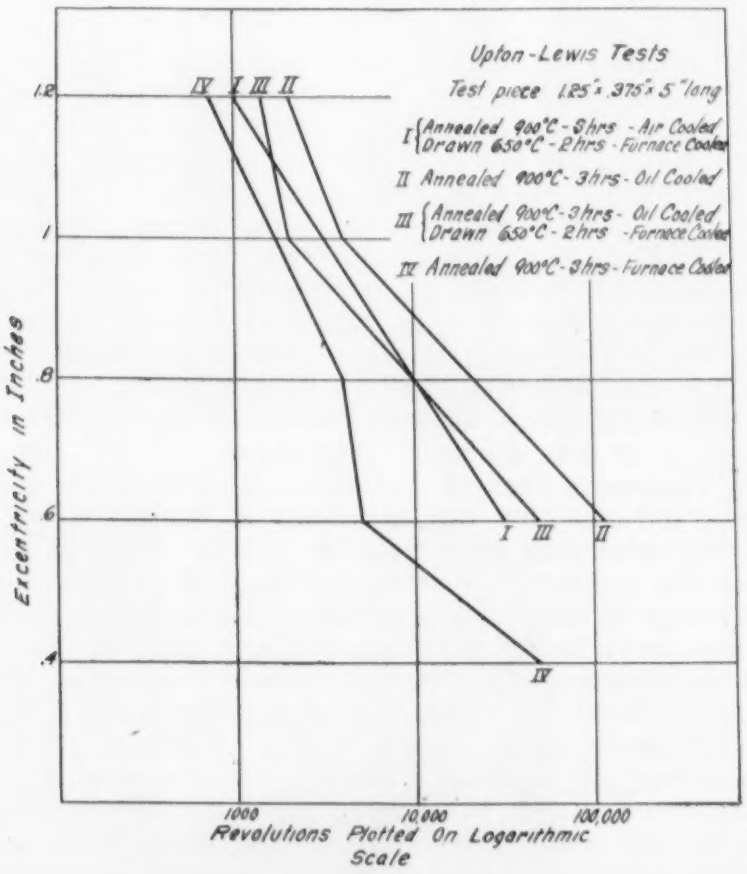

Upton-Lewis Tests
Test piece 1.25" x .375" x 5" long
I {Annealed 900°C - 3 hrs - Air Cooled / Drawn 650°C - 2 hrs - Furnace Cooled
II Annealed 900°C - 3 hrs - Oil Cooled
III {Annealed 900°C - 3 hrs - Oil Cooled / Drawn 650°C - 2 hrs - Furnace Cooled
IV Annealed 900°C - 3 hrs - Furnace Cooled
Eccentricity in Inches
1.2
1
.8
.6
.4
IV I III II
I III II
IV
1000
10,000
100,000
Revolutions Plotted On Logarithmic Scale

Fig. 13—Upton-Lewis Tests on Specimens Taken from Four Different Castings of About the Same Weight. Their Treatment is Indicated on Chart. The Results Shown Here are Representative of Regular Production Output

ing much more skill on the part of the operator and the results in most cases are not as good as those obtained in the electric furnace.

The described process is also very well suited for medium and hard castings when no drastic heat treatment is possible. During the cooling down a high tensile strength will be imparted to steels showing about .35 carbon and upward, and in regulating the following low temperature treatment wide variations in the strength and toughness of the material can be produced. Castings too low in carbon can likewise be brought up to the desired strength without risk of warping. The toughness even of big castings of mild steel subjected to the described treatment will show much higher figures compared with those obtained through slow cooling in the furnace from the annealing temperature. This point is not sufficiently recognized in the treatment of steel castings, as a much more drastic cooling is thought to be necessary.

The heat treating department will further be capable of a greater output

when operating with the electric furnaces, inasmuch as the castings will be finished in about 8 hours less time.

Years ago in standardizing the furnace handling of castings at Stavanger Electro-Staalverk, some endurance tests were made on steels corresponding to various heat treatments. Fig. 13 shows the result of a set of tests on steel for hydroelectric power machinery obtained in the Upton-Lewis machine. The test-bars were cut from castings of approximately the same weight (100 to 150 kilograms), which had undergone a heat treatment in the electric furnace as indicated on the chart, Fig. 13, the truckload in each case being 8 to 12 tons. The results therefore are thought to strictly correspond to the regular output, if treated as indicated. Fig. 13 demonstrates that at least for these small castings, oil and air-cooling with a following draw at 650 degrees Cent. gives nearly equal results, furnace-cooling gives decidedly lower values.

Summary

It is possible by proper heat treatment to bring the impact figure in steel castings nearly up to the toughness, which can be obtained in high nickel chromium steels for case hardening purposes. This refers to electric steel with about .20 carbon handled with great care during all stages of the process and subjected to a very mild heat treatment, or rather to be called repeated annealing, as no drastic cooling is used.

The author does not in any way claim originality in the advocated treatment, as many heat treaters have at times undoubtedly been forced to similar processes, but he does wish to show that specifications regarding impact toughness may be laid down and that they can be obtained by suitable heat treatments.

(*Continued from Page* 421)

SOME FUNDAMENTALS OF RESEARCH

course, to prevent overlapping of duties, with possibility of discord. The utmost of harmony and co-operation is essential in any organization. (The organization chart of the research laboratory of the General Motors Corporation, which details the problems confronting this organization, may be of interest and is included as a part of this paper.)

Research organizations must be schooled continually in simplicity of effort and measure their results by the yardstick of utility. The results of research work are ofttimes intangible; for, after all, the general product of research is *information*. That information must be founded on facts which, when worth while, can always be carried in small packages.

THE NEED FOR MORE PRACTICAL INFORMATION IN INDUSTRY

By Dr. J. S. Unger

Abstract

The paper makes a plea for more reliable data and information concerning many of the phases of endeavor in our industries. The author points out that there is a large amount of investigative work done which is of little value to anyone often including the investigator. Many people labor under the misapprehension that they are well informed on their subjects but in reality they are poorly informed.

Suggestions for possible researches and investigations are made by the author.

AT THE outset, the writer wishes to say that this paper is not a scientific one. In the steel business and such other industries directly connected with the steel business, frequent inquiries are made for information on certain subjects upon which an immediate reply is desired. To wait until an investigation can be made, may require days, months, or perhaps years and when completed, may then not be of value, as the question probably has been answered more or less completely by an actual experiment or trial, or from another source.

Need for Reliable Data

The motive which prompted this paper was the necessity of having complete data on hand or of constantly investigating subjects of practical value to the business and technical world. Many investigators are at work on problems that for the present are only of abstract value. The usefulness of the results will depend alone on their practical applications. The investigator does not have a fixed, definite practical aim or goal to which he may apply his results. The consequences are that the data obtained are not applied to a definite purpose and are eventually lost. Later, another may go through the same process and meet with the same results. History repeats itself. Until the information is actually applied to a given purpose, it is that much timber thrown to one side to decay.

The point which is emphasized is the lack of dependable information. Many people believe they have a thorough knowledge of a subject, but instead they simply have a smattering. Their knowledge or ignorance consists of opinions, something others have said, something they have read, or conclusions reached by them without any attempt on their part to prove or disprove their opinions.

In order to emphasize this, I will tell you of a number of incidents, being the experience of myself or others and you may be assured that they are not funny stories, but facts.

A gentleman, who had no claim on the chemist, and trying to get something for nothing, asked for the composition of rust on Bessemer and open hearth steels. He later explained he proposed to use it in some of his personal advertising matter. The chemist furnished the information gratis

A paper presented before the Pittsburgh Chapter. The author, Dr. J. S. Unger, is manager of the Central Research Bureau of the Carnegie Steel Co.

from results in his files. The analysis had not included combined water, oxygen or carbon dioxide. Imagine the chemist's feelings, when he was told publicly that the analysis was wrong, intimating the chemist was not dependable. A little information on the subject was needed in this case.

A young metallurgist was drawing back a furnace charge of steel pieces weighing about 1000 pounds each, at a temperature between 550 and 600 degrees Cent. as shown by a pyrometer which was placed at the middle of furnace lying on one of the pieces. An inspection by the eye while the gas was shut off the furnace for about one minute showed a temperature of somewhere between 750 and 800 degrees Cent. On checking the temperature with two extra pyrometers, temperatures of 785 degrees Cent. were found. The entire charge was spoiled having to be retreated from the very beginning. An absence of practical information is lacking in this case.

A works metallurgist who had just finished a long dissertation on the hardening of steel, explaining all about austenite, martensite and troostite, was asked what kind of case hardening compound he used, and at what temperatures he carburized and quenched his material. He could not give an answer, hiding his ignorance by sending to the shop to get information from one of the workmen.

Many Salesmen Little Informed on Their Products

Many salesmen fail because of a lack of knowledge of the real advantages or disadvantages of their goods, and a positive ignorance of the properties the article must possess to best fit it for what it must do in service.

An agent selling fluorspar was told by the customer, it must contain not less than 78 per cent calcium fluoride, not more than 5 per cent silica, nor more than 10 per cent calcium carbonate. He was very indignant claiming such requirements were impossible as it did not add 100, nor was any allowance made for the remaining compounds.

Brick representatives sometimes carry samples which they present, together with an analysis and the melting point of the brick. The samples are carefully selected to insure good workmanship, and freedom from surface defects. They claim almost everything for the quality. A carload shipment will show cracked, warped, broken brick, and some which differ in thickness by ½ inch. The chemical analysis is of little value, as the properties are profoundly affected by the manner of making. The melting point is of very little value, as the bricks could not be used at or near the melting point. The softening point or the ability to sustain a working load at working temperatures, (not in the cold condition), has not appealed to them. An absence of necessary knowledge is apparent.

A complaint was entered with a maker of steel ladle refractories. The stoppers he furnished were not round and would not fit the nozzle, making a liquid tight seat. This is essential to avoid a spattering of the steel over the moulds and cars, giving constant trouble. After he had presented a number of his regular make, which he considered perfect stoppers and finding they were unfit to use, being about as round as a horse's head, he prepared a new scale of prices, covering, No. 1 Regular; No. 2 Round; No. 3 Round and Polished. He could not see why his regular product was not good enough, although it was not tight for liquid steel, nor could it be used without entailing expense to the user. He had not studied working conditions.

How many agents for bearing metals know the physical properties of the white soft metals or the brasses or bronzes they sell. In most cases the

composition is a secret. When asked about the hardness, the compression, the strength, the ductility and the shrinkage, the best temperature for melting and pouring, and information on the frictionless quality, they can tell you little or nothing, yet these properties are the important things the user should have. Some manufacturers make regular tests, particularly in the brasses and bronzes, others do not. Very little testing is done on the soft metals, although two soft metals of approximately the same cost may show a difference in service of as much as 20 times.

A man selling a belt dressing made by a secret formula insisted it "gave life to the leather," and increased its strength. A short piece of leather belting was cut into two adjacent strips. He was given one piece to dress with his preparation. He returned the next day claiming the leather was more pliable and improved in strength at least 3 times. Much to his surprise he was shown that by soaking the leather in water a few minutes, the pliability was increased. The strips were tested to destruction. The dressed piece showed 80 per cent of the strength of the undressed. A clear case of lack of information.

A strip of leather was cut into 4 short pieces. The alternate pieces given to another representative to dress. The dressing smelled of tar and rosin but he insisted it contained nothing but animal greases. All samples were tested to destruction. The dressed pieces averaged 78 per cent of the undressed, and even then he wanted to argue the matter.

A secret dressing was applied to a strip of leather. Thirty minutes after application, it increased the adhesion or gripping quality on the pulley to four times that of the undressed strip. On being laid away for 3 days, it had fallen to 2½ times, after one week to 1½ times. The rapid decrease in adhesion was not hastened by any service.

A strip of leather laid in kerosene for two hours showed a decrease in strength of 40 per cent when tested the following day.

Many persons, some of whom, claim to know much about leather, will tell you that the thick part of a leather butt is much stronger than the thin. When asked to show their figures, they do not have any, nor can they understand why thin and thick strips from the same hide will prove the question in any way desired.

Some round steel rods in service were subjected to severe bending stresses, causing buckling or slight permanent bending of the rods, resulting in rapid failure from fatigue. The user claimed the rods were of poor quality, saying the steel of several years ago was of much better quality. He believed the composition and micro-structure was at fault and he was helpless. In going over the service records, it was found the service at the present time was in some cases three to four times as severe as it was some years ago. By devising a bending test on full-sized rods, making it very severe, then trying out various steels from the soft to the hard grades, it was soon found that a special, medium carbon steel was the best in test and in service. The customer had done nothing to investigate the service, nor did he think service was his problem. He took the position that he prepared the finished article, and any failures were due to the quality of the steel. He was told the service was becoming more severe and that he must increase the size of the rods, otherwise, breakages would be more frequent than in the past. He objected to this, claiming it would cost more. Here is a case in which real practical information was not desired.

A customer for plate steel presented specifications covering the regular maximum and minimum tensile properties and bend tests. In addition he

stated he wanted higher carbon, as he claimed he wanted a stronger steel. He specified a carbon content fully .15 points higher than could possibly be used to meet his specifications. He resented being told it was impossible to make such material of common steel, insisting upon his requirements, believing perhaps the carbon was applied by the steel maker similar to a coat of paint. Did the customer have even a practical knowledge of steel?

A customer using strip steel 5 x ⅛ inches insisted much better results were obtained by using soft Bessemer steel than similar basic open hearth steel as the latter would not produce straight work. A shipment of open hearth steel was made and carefully observed in service. No difference could be found. It was discovered that the first lot of open hearth steel was not straight, having been kinked in service, consequently, the work done by the steel was not of good quality. This defect was immediately assigned to the kind of steel used.

A user of acid open hearth steel said basic open hearth steel could not be used in the making of a small, untempered, common spring. Basic steel of the same physical properties was furnished for a trial. After fabricating the new steel and testing it by a crude shop method, he adopted the basic steel. At this time he will not accept acid steel.

A metallurgist complained about some plate steel, stating it contained too much ferrite. The other observers who witnessed the work the steel was doing were satisfied. The steel was returned. Another plate from the identical heat was furnished and was pronounced very satisfactory.

A construction firm was much impressed by the claims made by a maker of special high-elastic, high-tensile steel. It being 50 per cent higher than their regular steel. They were interested, purchasing some of this steel, but found they could not shear, punch or bend it cold without cracking or breaking it. It had to be worked at a red heat. They did not possess the equipment to work it hot, nor could they add the extra cost of the steel and the additional cost of working to their product. If the steelmaker had a practical knowledge of what was required of this steel he would not have recommended it for their purpose.

A complaint was received from a customer that rails furnished him were defective. He had the steel examined microscopically by a well-known firm of testing engineers, who submitted a report with micrographs, stating that they showed the presence of an excess of ferrite for this grade of steel. A letter was received from this customer, inclosing a copy of report with this notation: "You will note there is an excess of ferrite, which I believe is due to ferrite in the ore used in making this steel."

Steel rails are purchased by specifications, covering composition, drop tests, breaking tests and bending tests. A rail may meet such tests and give poor service, while another may fail in tests and give good service. Have the tests been correlated with service? Do the present tests really procure good rails? Have any comparisons in track been made by the railroads under exactly the same conditions to determine what qualities a rail should possess?

Hardness in metals may mean anything. We have rolling hardness, abrasion or scratching hardness, machining hardness, impact hardness, and resistance to deformation. A manganese steel rail may show a lower Brinell hardness than an ordinary rail, but may show a rolling hardness of 4 times that of the ordinary rail. Two steels of the same Brinell hardness may show twice as much resistance to machining when compared. With different metals, say

cast iron, bronze, hardened copper, and soft steel, very much greater differences in machining are found than in the Brinell hardness. Abrasion of steel by grit, sand or by grinding does not depend on the Brinell hardness. A soft steel compared with a medium hard steel, showed the following comparison:

Steel	Ultimate Strength	Brinell Hardness	Resistance to grinding by Carborundum Powder
Medium Hard	100 per cent	100 per cent	100 per cent
Soft	58 per cent	50 per cent	77 per cent

We need to know more about hardness, as what may be hard in one case may be relatively soft in another.

The resistance to corrosion of steel is sometimes determined by its resistance to solution in partly diluted acids or in a solution of brine. Exposure to the condition of service is not universally practiced, as it sometimes requires years for completion. The first tests are used as an index of quality even though they bear no relation to the resistance in service. Why should any confidence be placed in such tests?

It is sometimes assumed a good paint for wood is a good paint for metallic surface. Metallic surfaces may be hot as a boiler, a furnace or a hot blast stove. At times the hot surface may be drenched by a rain storm. Perhaps the paint may adhere but not protect the steel, at other times the paint will protect the steel but will not adhere, owing to the conditions of service. Should paints be selected for what they must do?

Many metals or alloys are added to steel to take out the gases, particularly oxygen. Anything that has an affinity for oxygen may be advocated. Some of those whose affinity is greatest at a low heat, function improperly at a high heat. Others are the exact opposite. Experiments have shown that outside of an actual trial, it is useless to say what a particular deoxydizer added to steel will do. Claims are advanced for the gaseous purification of steel by almost every new alloy produced.

Whether you are a producer, a consumer or salesman, more than beliefs or opinions are necessary. Practical information on your particular subject is essential.

Suggestions on Practical Problems for Investigation

There are many practical problems that require further investigation, and among the many in the steel industry, the following are a few examples:

1. What effect has superheated steam up to say 318 degrees Cent., 599 degrees Fahr., on the physical properties of the medium and high carbon steels? What effect is produced if such steels be cooled in hot water resulting from the condensed steam?

2. What force per square inch is required to compress or upset both alloy and plain carbon steels when they have been heated to working temperatures, or from 1000 to 1200 degrees Cent. such as would be used in rolling, forging or forging in a die? These steels to have the same physical properties in the normalized condition when cold. The same data for steels of unlike physical properties when cold?

3. What is the strength of various steels heated continuously from 500 to 900 degrees Cent. for many hours in a vertical furnace used to

heat guns or shafting for quenching or annealing?

4. Which is better, a casting or a forging, used under the above conditions for a suspending device?

5. What proportionate reduction of area from an ingot to a rolled or forged piece is of value? At what point might the reduction cease as being of no further benefit other than that it would give a lower finishing temperature, resulting in better grain refinement?

6. Do the projections on twisted or otherwise deformed bars for concrete reinforcement add anything to the strength of the concrete structure as a working unit?

7. Is the X-ray of value in showing an interior defect in steel if the sides of the cavity lie close together?

8. Through what thickness of steel is it commercially practicable to secure a radiograph clear and distinct enough to be of value?

9. Can interior defects in steel, the sides of which lie close together be shown by magnetic examination?

10. Which has the better properties,—a sound properly heat treated steel casting or a forged or rolled piece of the same steel and same heat treatment?

11. Does the addition of a few hundredths of a percent of phosphorus to basic open hearth steel improve the welding properties?

More Practical Information Needed

In closing I want to leave a few thoughts with you. Our journals and magazines contain many articles describing work done in a very small way. A few small specimens or examples are used from which broad general conclusions are drawn, not adapted to service nor practicable of execution.

To secure real practical information the tests should be made on as near the full-sized material as possible and under conditions closely approaching service. Such tests must be more severe than actual service, otherwise, the test is unduly prolonged. Sometimes this can not be avoided. Service is not standard, as many variables exist which may lead to the wrong conclusions. Any kind of service is not a true criterion of service. Service tests must be carefully standardized in order to repeat them if necessary. It is always wise to use a unit for comparison or a measuring stick of a known material in conjunction with the unknown in service, to be certain of results. If tests be made, they must be of such character to be correlated with service and show qualities of actual value.

Much time is spent in trying to find a reason for certain phenomenon, and many theories have to be advanced to explain it. The isolation of a particular disease germ is of great value, but the greater benefit is obtained by finding out how to combat or destroy it. We do not know just what electricity is, but we do know how to use it to benefit mankind. Instead of spending so much time trying to find the cause, we should take the effect as it exists, and try to improve the condition, not by theorizing, but by actual trial or tests.

My aim in this paper, and I hope I have shown it, is the need for more practical information in industry.

A METALLOGRAPHIC STUDY OF HOLLOW ROCK DRILL STEEL, AS INFLUENCED BY THE METHOD OF MANUFACTURE

By N. B. Hoffman

BY THE term *hollow rock drill steel,* the author refers to bars of tool steel either round, hexagon, octagon, quarter octagon or other suitable sections containing a round hole running the longitudinal axis of the bar. The hole in the bar has several functions, most important of which is the passing of water through the bar during drilling to the cutting face of the tool, thereby eliminating dust and at the same time washing out the pulverized rock as fast as produced, thus giving the tool a clear working area at all times. Another great virtue is its protection to the health of the driller, due to the elimination of dust.

Hollow rock drill steel without doubt had its inception in England, and one of the earliest patents recorded for the manufacture of hollow materials, rods or tubes, was granted to James Newman, of Birmingham, England, on Nov. 28, 1854. This product, however, was not used for rock drill steel, but the process finally led up to its production. Newman's patent covered the invention of lap welding skelp, and filling the resultant tube with sand, then drawing it out through rolls, after which both ends of the rod or tube were cut off and the sand drilled out. The method employed in England and the United States today, covers the same general idea, that of filling with a refractory material, and removing same after rolling.

Method of Manufacture

The following is a brief description of the method used at the present time. A hole is drilled through the center of a bar or billet along its longitudinal axis, and of sufficient size to produce a hole of a given diameter in the finished bar after rolling. The hole in the billet or bar is next filled with a suitable refractory material and both ends plugged. This billet or bar is then hot rolled to the size desired, and when cold, both ends are cropped and the filling material removed, employing one of two methods, either by air or water pressure. Several other methods of manufacture are used in the United States, but the general idea of filling the hollow billet or ingot with a refractory material, and after hot rolling removing the filling material, has proved to be the most satisfactory and has been generally adopted.

In Sweden, a prominent producing center of hollow rock drill steel, other methods have been adopted for keeping the hole open in the stock during the rolling process. In some instances the billet is pierced and rolled down with mandrels inserted through the hole, which are taken out and exchanged for ones smaller in size each time the piece is passed through the roll. Another method commonly used, is to first pierce the billet, and then keep the hole open during rolling by forcing a current of air through it at high pressure and thus cool it while the remainder of the piece is still hot. The compression and contraction in size, therefore does not close up the hole entirely. While the finished

---

A paper presented before the Detroit Convention, October 2-7. The author, Dr. N. B. Hoffman, is metallurgist with the Colonial Steel Co., Pittsburgh, Pa.

product made by the various processes are similar in character, yet each type differs slightly from the other in some degree.

Until the last two years, practically all rock drill steel used was made of carbon steel, the alloys being neglected. But the demand for production and the gradual increase in size of the pneumatic drilling machines, placed an unusually heavy burden upon the rock drill, and many mining engineers began asking for a better quality of steel to enable them to increase their efficiency and production, much of their trouble being due to breakage and low cutting efficiency of the bit. What they needed was a steel which would withstand impact and at the same time retain a sharp cutting edge. That is a steel with a tough stiff body with high fatigue values, and a point which when forged and hardened, would be both hard and tough, and one that would hold its gage under all conditions.

In developing a steel with all the foregoing qualities, several other factors must be taken into consideration. First, it must be of a composition that any blacksmith can easily forge and heat treat. Secondly, its price range must be such that it will not be prohibitive to the smallest consumer. In developing such a product, we naturally turn to the alloy field. Chrome, chrome vanadium, chrome nickel and various other alloy combinations have been tried, and I believe without result, due in great part to the complexity of heat treatment. The composition found to give excellent results in actual practice thus far, is a vanadium steel with a composition as follows:

Carbon	.75-.85
Manganese	.25-.35
Phosphorus under	.020
Sulphur under	.025
Silicon	.12-.16
Vanadium	.20

A large number of tools of like character, and the nature of whose work required similar properties, have been used in the industries for years and have to a very great extent displaced the carbon steels. A steel of this type has excellent fatigue values as well as stength. A 1¼-inch cube quenched in water at 1500 degrees Fahr. and drawn in oil at 415 degrees Fahr. will withstand a compression load of 250 tons, and in crushing down seems to tear apart, while the carbon steel shatters. It also has a scleroscope hardness as high as the carbon steels.

Francis B. Foley, metallurgist of the United States Bureau of Mines, in a paper presented before the American Institute of Mining and Metallurgical Engineers, Feb. 19, 1922, quoted some very interesting data from the *Canadian Mining Journal* of Jan. 15, 1917, which shows that most of the breaks in rock drill occur during the early life of the steel, and that as a given batch of steel is used, its percentage of breakage decreases, and that this fact is at variance with the much-talked of theory concerning failure from crystallization and fatigue. It seems to point to the fact that the greater part of drill steel failure from breakage, is traceable to faulty manufacture resulting from defects in the bore of the hollow steel, such as slag, oxides, etc., and as this defective material meets with early failure, it is weeded out. In addition, some breakage may be caused by a lack of proper condition with

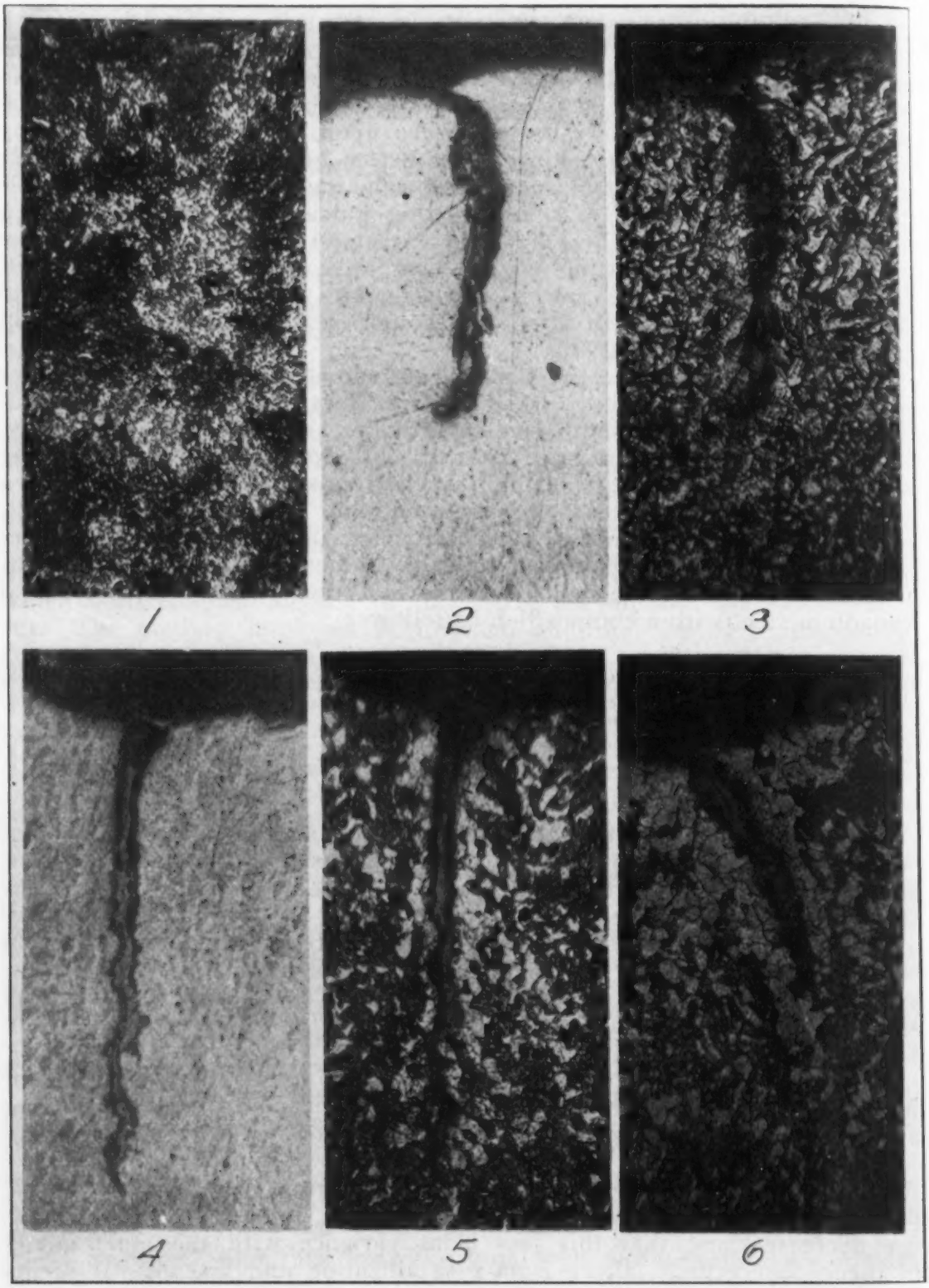


Fig. 1—Normal annealed structure of bar. Fig. 2—Showing crack on a polished and unetched annealed section. Fig. 3—Same as Fig. 2 after hardening and etching. Fig. 4—Polished and unetched hardened section showing crack. Fig. 5—Same as Fig. 4 after etching. Fig. 6—Another hardened and etched area showing crack. Note the completely decarburized area surrounding the hole as shown at left of photomicrograph. All magnifications × 100.

respect to heat treatment of the steel as furnished by the manufacturer. These points would seem to be well taken and worthy of serious consideration.

Bits Fail Due to Fatigue

The question of fatigue to withstand vibratory shocks and stresses, would seem to be absolutely vital to the production of a successful rock drill steel. But several interpretations are placed on the word *fatigue* and I will quote you from the analysis given the term by Prof. H. F. Moore, of the University of Illinois, who has done much work on the fatigue of metals. He says, "the view is summed up in the word *crystallization.*" The idea was that under repeated stress the material changed its crystalline structure, and he states "that he does not know of any evidence in favor of the theory that metals materially changed their crystalline structure under repeated stress. The crystals are broken under repeated stress." The second theory, advanced by Bauschinger, the German scientist, is that "under repeated stress some inherent property of the material changes its elastic limit, it is an inherent property of the material, possibly some property of the amorphous cement between the crystals." The third view is that all fatigue of metals is the result of the spread of damage from little localized overstresses.

Prof. Moore, says he does not feel justified in stating his positive belief in the third view as against the second, but has yet to find a case of fatigue of steel or other metal, either in the laboratory or in service that could not be explained by the gradual spread of damage from some nuclei. While feeling satisfied that breakage is caused by the gradual spread of damage from nuclei or weak spots such as radial cracks, slag or oxide pockets, yet a steel with high fatigue values would fail far less early than one with low values.

Test Procedure

Tests were run using a plain carbon steel and a vanadium steel to determine their shock resisting or fatigue qualities, using 4-foot test bars as a standard. The bit ends of the test bars were faced off flat similar to the chuck ends. A 248 Ingersoll-Rand drill, mounted on a column, was used for all tests. The tests consisted in using the test bars like a drill steel, allowing the bit end to strike against the face of a sixteen pound sledge, wedged in a 4-inch diameter hole in the solid rock. An adjustable arm with a 1 7/16 inch diameter hole in it was supported from another column, so that the test bar could be placed through the hole and the arm adjusted so that the hole would line up with the chuck of the drill. The test bar being placed through the hole in the adjustable arm could not get out of line. Care was taken also, to see that the flat bit end of the test bar struck the face of the hammer squarely. The adjustable arm supported the test bars 12 to 14 inches from the bit end. Care was taken to see that the sledge did not show movement during tests. The bars were tested by operating the drill until breakage occurred, noting the time in minutes and seconds.

The size of the steel used was 1¼ inch hollow round, and all bars were 4 feet long. Five test bars of carbon steel and three of vanadium

steel were used. All blacksmithing and heat treating was performed by the same man and conditions were as nearly identical as possible.

The result of the fatigue tests showed the vanadium steel to have a life over three times as long as the carbon steel.

Numerous tests have been run in actual drilling operations which have shown the vanadium steel to have fatigue values at least 50 per cent greater than carbon steels or at least the breakage is reduced 50 per cent.

To get a comparison in actual working conditions, a carefully conducted test was run by a large gold mining company using 10 bars of 1-inch hollow octagon carbon steel, and 10 bars of 1-inch hollow octagon vanadium steel. The two steels were manufactured exactly alike in every detail and the only difference was that 10 bars contained approximately 0.20 per cent vanadium. The samples were run side by side for four months in stopes of hard rock, and a breakage record of the two steels was kept with the following results:

	Percentage of Breakage in four months	
	3-ft. Drills	4-ft. Drills
Carbon Steel Hollow Drill	5.69	4.48
Vanadium Steel Hollow Drill	2.46	2.19

In practically every case where comparative tests of vanadium and carbon drills were run, the results showed the vanadium steel to have at least 50 per cent less breakage and that it held its gage 30 per cent to 50 per cent longer.

The hollow rock drill manufactured by piercing and chilling with air or that manufactured by piercing and rolling down on mandrels, abound in minute cracks or folds radiating from the hole in the bar; which areas would seem to be weaker than the areas surrounding them. Another feature of the pierced and rolled or drawn bar, is that the area surrounding the hole is decarburized to various depths. This is true of all other pierced stock that I have ever seen no matter for what purpose used. But in practically every instance to my knowledge where the pierced stock before using is hardened and drawn and used as such in other classes of work, the decarburized area is removed in machining operations incidental to the forming of the tool.

Types of Steel Tested

The first two samples examined were of the type in which the holes were kept open during rolling either by means of mandrels or compressed air.

The sections examined in the first sample, and as represented in photomicrographs, Figs. 1 to 6 inclusive, were cut from a 1¼-inch round, and had the following chemical composition.

Carbon	.82	per cent
Manganese	.21	per cent
Phosphorus	.023	per cent
Sulphur	.017	per cent
Silicon	.11	per cent

This bar had numerous radial cracks or folds radiating from the

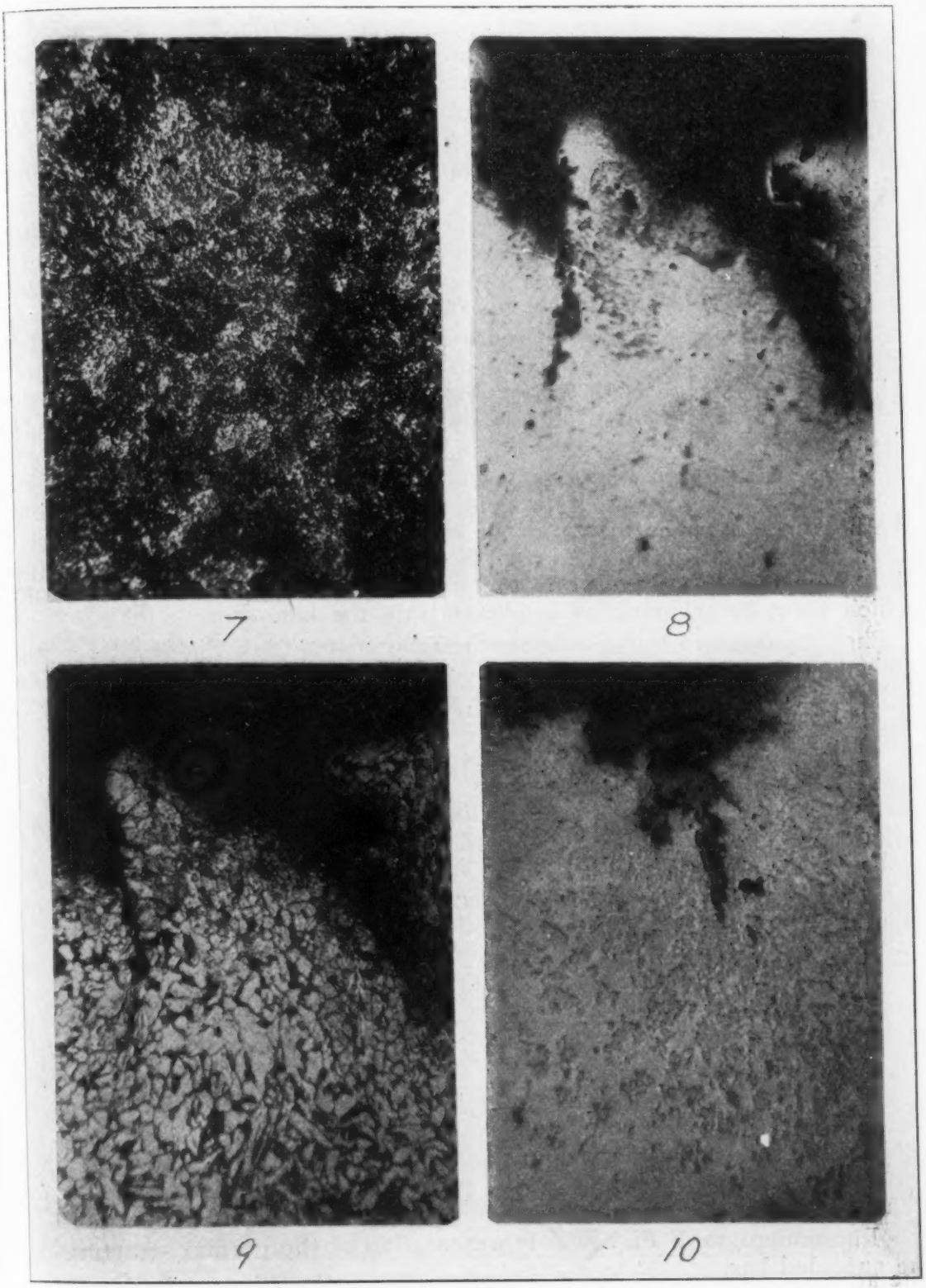


Fig. 7—Normal structure of annealed bar. Fig. 8—Photomicrograph showing two folds or cracks running in from hole. Specimen annealed and polished but unetched. Fig. 9—Same as Fig. 8 after etching. Fig. 10—Hardened and polished area showing crack extending from the hole into the bar. All magnifications × 100.

hole, and while the metal in the area surrounding the hole is decarburized to a more or less uniform depth, yet the area surrounding the cracks or folds is decarburized through their entire length, which in some instances was 3/16 inches deep. These areas would absolutely represent weak points in the bar and early failures would undoubtedly occur through those areas.

All photomicrographs shown are 100 diameter magnifications, and all etching was done with nital.

Photomicrograph Fig. 1 is representative of the normal annealed structure of the bar, while photomicrograph Fig. 2 shows a crack or fold ⅛ inch deep on a polished and unetched annealed section, extending from the hole in the bar as shown at the left of the photograph.

Photomicrograph Fig. 3 represents the section shown in photomicrograph Fig. 2, after hardening, as etched to show the grain structure. The heavy white areas of ferrite low in carbon, extend beyond the fold and the carbon content of the whole area would possibly not be more than 0.20 per cent.

Photomicrograph Fig. 4 represents a polished and unetched hardened section containing a crack or fold 3/16 inches deep, extending from the hole in the bar as shown at the left of the photograph. The mottled area extending from the defect, shows the extent of decarburization, that immediately adjacent to the crack is totally decarburized, from which point decarburization graduates into the bar.

Photomicrograph Fig. 5 represents the area shown in Fig. 4 after being etched, and portrays the lines of complete decarburization as seen to better advantage in the heavy white areas, as well as the gradual decarburization into the body of the bar.

Photomicrograph Fig. 6 represents another hardened and etched area of a fold or crack, showing the completely decarburized area surrounding the hole as shown at the top of the photograph, and that adjacent to the defect in the bar, as seen in the heavy white areas, as well as the gradual decarburization into the body of the bar.

A second sample of the preceding type examined was also cut from a 1¼-inch round and had the following chemical analysis.

Carbon	.90	per cent
Manganese	.23	per cent
Phosphorus	.020	per cent
Sulphur	.017	per cent
Silicon	.14	per cent

This bar also had numerous folds or cracks running through it radiating from the hole, but in this specimen we do not find the defects extending so deep in the bar as in No. 1, while the decarburization in many areas was deeper.

Photomicrograph Fig. 7, is representative of the normal structure of the annealed bar.

Photomicrograph Fig. 8, on the top of the photograph representing the hole, shows two folds or cracks on a polished and unetched annealed specimen extending from the hole into the bar.

Fig. 9, represents the section shown in photomicrograph Fig. 8,

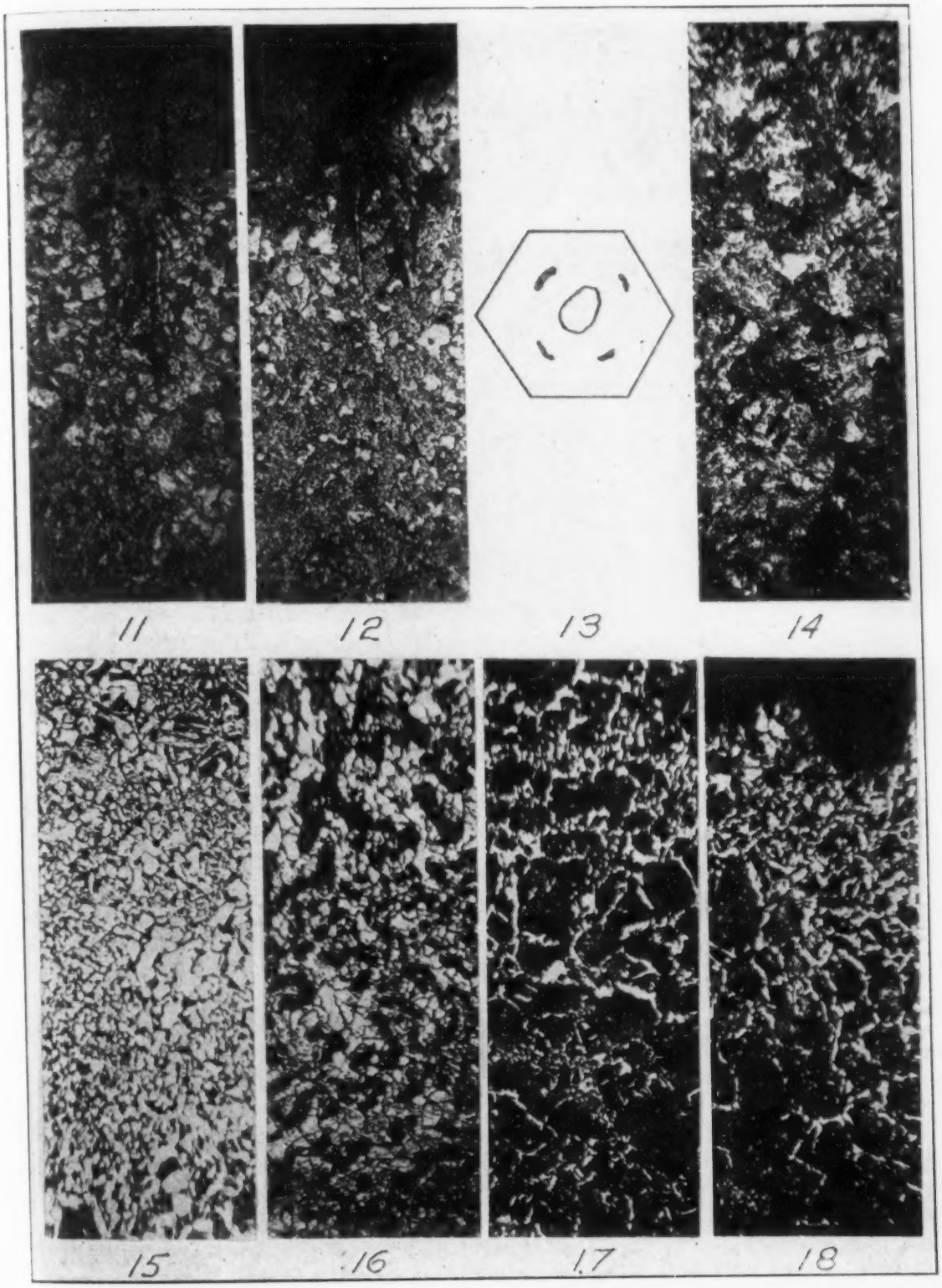


Fig. 11—Same as Fig. 10 etched. Fig. 12—Shows hardened section adjacent to hole. Fig. 13—Sketch showing location of soft spots caused by the method of casting the ingot from which the bar was made. Fig. 14—Normal structure of annealed bar. Fig. 15, 16 and 17—Specimens polished and etched to show grain structure in three of the soft spots. Fig. 18—Annealed area adjacent to hole, showing rough edge but no cracks. All magnifications × 100.

as etched to bring out the grain structure. The heavy white areas of ferrite low in carbon extend ¼ inch into the body of the bar. The surface of the hole is shown at the left of the photomicrograph.

Photomicrograph Fig. 10, is a hardened and polished area showing a crack or fold extending from the hole into the bar as is shown at the left with the mottled-like areas of ferrite low in carbon adjacent and extending beyond its tip in the body of the bar.

Photomicrograph Fig. 11, represents the area adjacent to the hole as shown in Fig. 10, when etched to bring out the grain structure. The heavy white areas of ferrite are almost completely decarburized.

Photomicrograph Fig. 12, is a view of another hardened section adjacent to the hole in the bar, as shown at the top and shows a slight crack or fold with the ever present area of ferrite low in carbon.

The next sample examined was a ⅞-inch hexagon bar with the following chemical composition.

Carbon	.70	per cent
Manganese	.21	per cent
Phosphorus	.007	per cent
Sulphur	.018	per cent
Silicon	.14	per cent

This specimen was manufactured from a hollow ingot cast as such and not drilled, but the hole in the ingot was kept open during rolling by filling with a refractory material. This bar showed four soft spots each of which formed a corner of a square, approximately half way between the hole and the edge of the hexagon as shown in sketch Fig. 13. This condition was caused by the method of casting the ingot from which the bar was made and not by any subsequent rolling operation. Photomicrograph Fig. 14, represents the normal structure of the annealed bar.

In photomicrographs Figs. 15, 16, and 17, the samples are polished and etched to show the grain structure in three of the soft spots. The heavy white area of ferrite in Fig. 15, shows it to be almost completely decarburized. Photomicrograph Fig. 16, shows one of the spots after a section of the bar had been hardened showing the soft grains of ferrite which will not harden. Photomicrograph Fig. 17 shows the area in that particular spot to be decarburized, although not as badly as in either Fig. 15 or 16. The carbon content was so low in the four spots that those areas could not be hardened. Photomicrograph Fig. 18, is representative of the annealed area adjacent to the hole in the bar, as shown at the top, and is very low in carbon. The edge is rough, but we have no cracks or folds.

We will next consider two samples of hollow drill manufactured by drilling the bar or billet and keeping the hole open during rolling with aid of a refractory material, which is the method most generally adopted in the United States.

The sections used in the first sample were cut from an annealed 1⅛ inch round bar, and had the following chemical composition.

Carbon	.83	per cent
Manganese	.31	per cent
Phosphorus	.009	per cent
Sulphur	.022	per cent
Silicon	.14	per cent

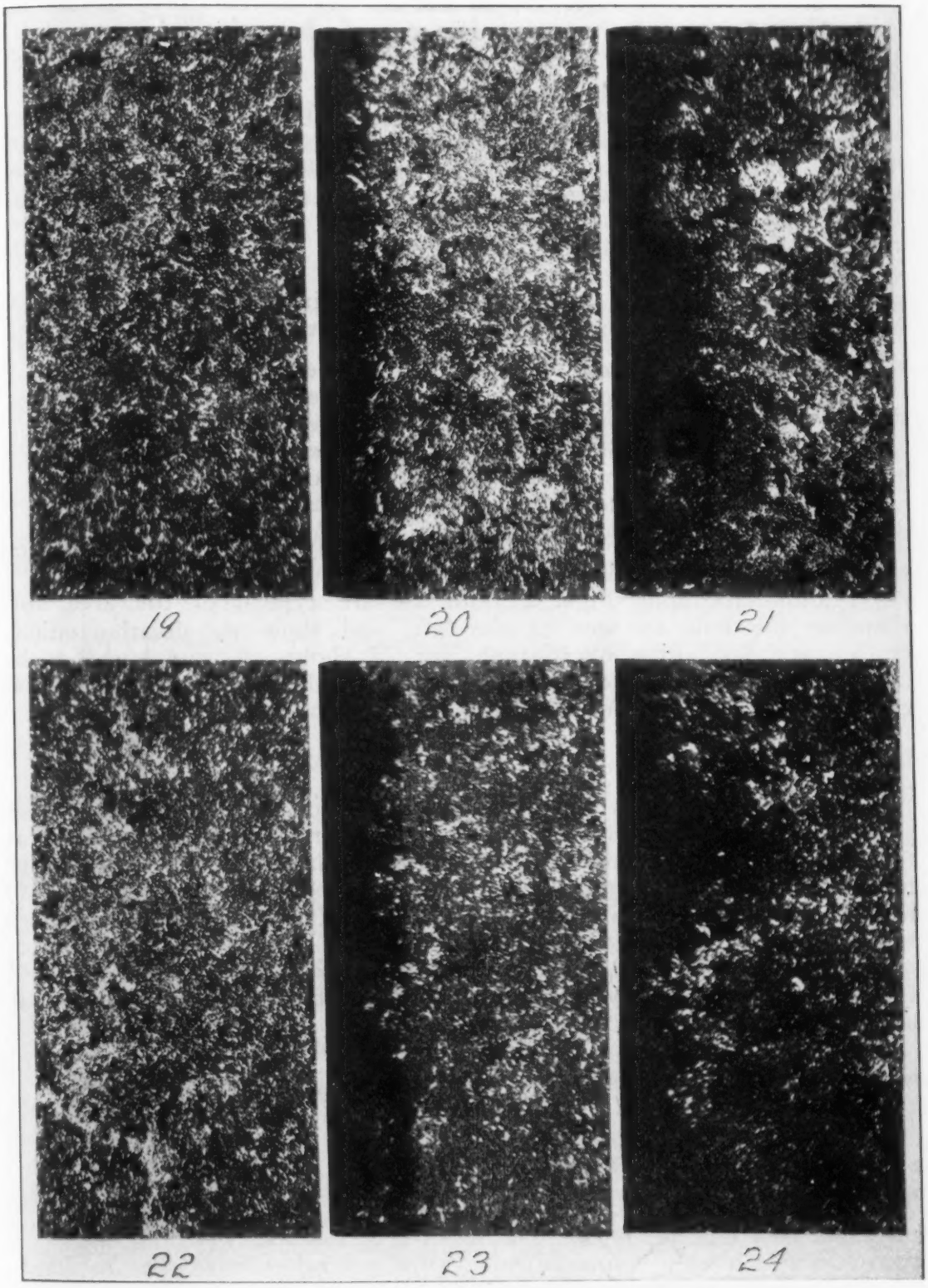


Fig. 19—Specimen showing a normal pearlitic condition. Figs. 20 and 21 are typical of the area surrounding the hole and shows no decarburization or cracks. Fig. 22—Polished and etched specimen showing a normal pearlitic condition. Figs. 23 and 24 are typical of the area surrounding the hole, showing no decarburization cracks or folds.

Photomicrographs Figs. 19, 20 and 21, are representative of the bar, and show the grain structure to be very uniform throughout, with no decarburization and no cracks, folds or weak spots radiating from the hole.

Photomicrograph Fig. 19, is representative of the polished and etched structure of the bar, and shows a normal pearlitic condition. Photomicrographs Figs. 20 and 21, are typical of the area surrounding the hole as shown at the left, and shows no decarburization, cracks or folds. Micrograph Fig. 21, shows the metal wall to be more uneven than in Fig. 20, but neither of them show anything that could be termed points of weakness in the metal wall.

The second sample considered is a vanadium steel of annealed 1¼ inch quarter octagon, and has the following chemical analysis.

Carbon	.85	per cent
Manganese	.28	per cent
Phosphorus	.007	per cent
Sulphur	.023	per cent
Silicon	.16	per cent
Vanadium	.20	per cent

Photomicrograph Fig. 22, is representative of the polished and etched structure of the bar, and shows a normal pearlitic structure.

Photomicrographs Figs. 23 and 24, are typical of the area surrounding the hole as seen at the left, and show no decarburization, cracks, or folds. Photomicrograph Fig. 23, shows the metal wall to be more uneven than in Fig. 24, but neither of them show anything that could be termed points of weakness in the metal wall.

Conclusion

In conclusion I would say the vanadium drill has one other strong point in its favor, that of heat treatment. In forging and heat treating the bits, the tendency is to carry the heat so high as to be injurious to the carbon steels, they having a comparatively narrow safe heat treating range, while that of the alloy bit is much higher thereby making it more fool proof.

While there is no doubt that considerably more carbon rock drill steel is being used today than alloy steel, yet I am a firm believer that before long conditions will be reversed.

The Question Box

A Column Devoted to the Asking, Answering and Discussing of Practical Questions in Heat Treatment—Members Submitting Answers and Discussions Are Requested to Refer to Serial Numbers of Questions.

NEW QUESTIONS

QUESTION 61. *What are the causes of scaling or spalling of the case of a carburized steel?*

QUESTION 62. *What is the difference between annealing and normalizing steel?*

QUESTION 63. *What causes the surface of a carburized steel to become pitted as a result of carburizing?*

QUESTION 64. *To what extent can the deep etching of specimens of steel be applied to routine examination of incoming material?*

QUESTION 65. *What is the relation between the elastic tensile strength and the elastic compressive strength in ductile steels?*

ANSWERS TO OLD QUESTIONS

QUESTION NO. 27. ***What is the function of the high phosphorus and the high sulphur content in the so called automatic screw stock steel?***

QUESTION NO. 35. *What is the difference between red annealed and blue annealed sheet steel?*

ANSWER. By A. L. Meyer, metallurgical engineer with the Alan Wood Iron & Steel Co., Ivy Rock, Pa.

The term *red annealed* is a misnomer, due to the fact that sheet steel being of red color has been rolled at a temperature below the critical range, which results in a red or ferrous oxide scale formation. Being rolled at such a low heat the sheet has become hard, due to lack of temperature for annealing and proper rearrangement of grain structure. This condition generally exists previous to the *blue annealing*. This latter condition is brought about by passing the rolled sheet through a furnace whose temperature is

above the critical range and whose condition will permit annealing and produce a blue or magnetic scale.

ANSWER. By E. J. Lowry of the Hickman, Williams and Co., Philadelphia, Pa.

Sheets are hardly ever sold in the original rolled condition. As such, they are called *red hard sheets*. It is believed that this is what the question refers to as a *red annealed sheet* which has not been commercially heard of. Nearly all sheets are annealed to be sold as *black plate*. The anneal consists of piling on a bottom and covering with a steel cover to prevent oxidation. This is known as box annealing. They are then heated to 1400 to 1600 degrees Fahr. for 16 to 20 hours. By another method, the sheets are allowed to cool after rolling and then passed singly through an open furnace where they are heated to the proper annealing temperature. The properties of the two kinds of annealed sheets are quite similar, the main difference being in the color. The latter method of annealing gives what are termed *blue annealed sheets*.

ANSWER. By G. A. Reinhardt, metallurgist with the Youngstown Sheet & Tube Co., Youngstown, O.

Mr. Reinhardt says: "I must admit that during my experience with sheet steel, I have never encountered the term *red annealed* sheets. Our sheet mill superintendent informs me that this is not a commercial phrase as he has never heard of it before.

"Annealed sheets are frequently spoken of as box annealed; white annealed or deoxidized; blue annealed; furnace annealed or pack annealed."

QUESTION NO. 46. Is the practice of buying high-speed steel by brand names instead of physical, chemical and metallurgical specifications justifiable?

ANSWER. By E. J. Lowry of Hickman, Williams & Co., Philadelphia, Pa.

The subject of "brands" is an interesting one. It has been argued for years and there have been established many "pros and cons" in nearly every industry. To justify it in metallurgical operations, one has to seek the traditions of the industry. Still further, its life has been the outgrowth of processes defined to make a product superior to a competitor's, and yet brand conveys little or nothing to the consumer. It does not guarantee the "pre-natal" conditions of the material. It is the producer who gives this guarantee. The brand is actually produced under chemical and physical specifications.

To adopt such specifications as science has to offer today, in purchasing material, will not, however, serve to eliminate the trouble which exists from a poorly made product. Neither can "brand" specification guarantee a product, but specification buying tends to aid the purchaser in standardizing materials, and is a step forward in progress, and is to be heartily recommended when used in connection with recognized producers.

QUESTION NO. 47. What is meant by "secondary hardness" in the tempering of high-speed steel?

ANSWER. By E. J. Lowry of Hickman, Williams and Co., Philadelphia, Pa.

Edwards & Kikkawa state as follows:

"The first effect of tempering hardened high-speed steels is to make them softer, but when they are tempered at higher temperatures they again become harder, and after heating at or about 614 degrees Cent. (1137 degrees Fahr.) they are much harder than in the initial air quenched state. There can be no doubt that this *secondary* hardening is the cause of the improved cutting powers of a tool, which Mr. Taylor found brought about by a secondary low heating to about 620 degrees Fahr.

"In order to get the maximum secondary hardness, the tungsten must have been placed in good solution by the primary hardening operation. It is very important to remember that different analyses of high-speed steel require different temperature treatments to obtain similar results."

QUESTION NO. 48. What are dendrites and how may they be detected?

ANSWER. By E. J. Lowry of Hickman, Williams and Co., Philadelphia, Pa.

Dendrites are the "pine tree" crystals caused by the freezing of metals from their molten condition. The branches enclose much of the impure metal, preventing its diffusion centerward. They are greatly aggravated when the metal is poured in contact with a "chill." They are commonly found in ingots and chill cast iron work.

Surface dendrites may be found by machining at right angles to surface. The dendritic structure shows up smooth and close compared to the openness of other grain structures.

QUESTION NO. 49. Can dendrites be removed through a proper heat treatment?

ANSWER. By E. J. Lowry of Hickman, Williams & Co., Philadelphia, Pa.

Dendrites may, in proper, be broken up by a proper heat treatment. The original contours of the grain will, however, always prevail. Mechanical work and heat treatment are the only reliable methods for breaking up a dendritic structure.

QUESTION 53. What is the composition of the so-called semi-steel?

QUESTION 56. Which is the best method of producing large forgings, pressing or hammering?

QUESTION 57. Does repeated heating just above the critical range with subsequent quenching of a steel specimen injure its physical properties?

QUESTION NO. 58. What is the cause of brittleness resulting from the carburizing of steel?

ANSWER. Brittleness, when caused by faulty carburizing, is due to excessive concentration of carbon in the surface of the steel as the result of too high temperature, or the use of carburizers that are too "sudden." Some carburizers are not only too rapid in their action to be safe, but when analyzed show high percentages of sulphur and phosphorus; these elements are conducive to brittleness, are as easily absorbed as carbon, and, in fact, sulphur has been proven to be an effective "carrier" of carbon, performing the same function as carbon monoxide gas. It is well to watch carbonizers that contain a large percentage of coke, either Solvay or petroleum, as they nearly always contain large percentages of those two trouble-makers for the steel treater. The cause of checks, or cracks, in the surface of carburized steel (sometimes so small they can not be seen until the surface has been polished, and for that reason called "grinding cracks"), may be found in excessive carburization, or may be due to sulphur in the steel.

QUESTION 59. Is a sulphur content of 0.067 per cent detrimental to the proper carburizing of a low carbon steel having a low manganese and phosphorus content?

QUESTION NO. 60. What is the cause of distortion of carburized parts of regular conformations?

ANSWER. Distortion sometimes occurs in carburized parts of regular conformations, and apparently, with no accountable reason, but the reason exists, and is generally revealed when investigation discloses non-uniform carburization. For instance, some wristpins, approximately 6 inches in diameter and 14 inches long, were carburized, and after heat-treating, were found to be ⅛ inch shorter on one side. They were file hard all over, and after much theorizing it was decided to break one of them to discover the cause of the trouble. The fracture showed a very heavy penetration on one side while the other side had less than half as much. With a little observation the cause of the distortion in this case might have been discovered, and avoided, without breaking the pin. The pins were packed one in a pot and placed in a furnace in two rows. The furnace was so constructed that the hot gases from the combustion chamber below came into direct contact with the pots on one side while their other sides received the heat by radiation from the arch only; with the result that the pins were at a carburizing temperature hours longer on one side than the other, consequently uneven carburization occurred, and in the quenching the pins were pulled short on one side, and a large amount of material, besides time and labor, were utterly lost. Cracking and distortion are the most costly of all carburizing failures, and everything possible should be done to avoid them. Most of these failures may be avoided by giving careful attention to the uniform heating of the steel during carburizing and heat-treating.

Comment and Discussion

Papers and Articles Presented Before the Society and Published in Transactions Are Open to Comment and Criticism in This Column—Members Submitting Discussions Are Requested to Give Their Names and Addresses

QUESTION NO. 36. Can mixed lots of steel be identified with a certainty by the aid of the grinding wheel spark test?

An answer to this question was published in the August, 1922 issue of TRANSACTIONS. The answer was an excerpt from a paper presented in Vol. II No. VI *Proceedings* of the Steel Treating Research Society, written by Prof. John F. Keller.

The following discussion of the answer to this question was recently received from Arthur S. Townsend, chief chemist of the Cleveland Twist Drill Co., Cleveland.

"The answer to question No. 36 in the August issue of the TRANSACTIONS, pages 1052-54, discusses at some length the spark testing of steel. This answer certainly must have been extremely interesting to all members of our Society who had ever made any previous study of this subject. The answer contains some real information on a subject which has only rarely been discussed in our technical literature and for this reason it is to be commended. It also contains some inaccurate statements which must be classed as misinformation. The color of the spark of high-speed steel for instance is not a "dark yellow," it is a dark red. The general explanation regarding the appearance of the various sparks is good and fully stated, but the meaning of some of the sentences is not clear, and some paragraphs are so worded as to be confusing, if not actually misleading.

"The chief objection to this answer, however, is that it implies that the spark test is a more valuable test than it actually is. The author is entirely too optimistic. Take this statement for example: 'To determine the quality by the spark analysis is not at all difficult if we have a known standard sample to compare with the metal under test.' As a matter of fact, it is actually often very difficult to determine 'the quality' in this way (even assuming that 'quality' here means kind). It is true that the spark test is useful occasionally for sorting out low and high carbon steels of a simple type, or for separating high-speed steel from carbon, but it is hardly correct to imply, as the author has done, that a miscellaneous collection of steels such as is listed on page 1054 can be sorted out by spark testing alone. It is also misleading to claim that the spark test can be successfully used to distinguish different brands of high-speed steel, one from the other.

"The spark test is crude, but it has the great advantage of being rapid and convenient. If pieces of steel of unknown composition are brought in for examination the first thing to try is the spark test, because this will very roughly classify the steel. If tools have been made from steel, the previous history of which is unknown, it is necessary before hardening to make use of either chemical analysis, thermal analysis or hardening tests—certainly something in addition to 'spark analysis.' The spark test is useful, but its limitations as well as its applications should be clearly understood."

Abstracts of Technical Articles

Brief Reviews of Publications of Interest to Metallurgists and Steel Treaters

SERVICE FOR MEMBERS

The Library Bureau of the American Society for Steel Treating is operated to give to the members quickly, reliably and at the minimum expense the following service:

1. A complete copy of the magazine article referred to in any periodical you may be reading.
2. A translation of foreign articles that would help you with your work.
3. A list of references to books and articles on any metallurgical subject.
4. Informing the members of new articles of interest to them as an engineer.

The Library Bureau makes the entire field of literature available to every member, distance is eliminated, for it will copy the desired information and send it to you. It also helps the busy man by supplying information without any expenditure of his time. The charge for this personal work is merely its cost.

The Library Service does not obtain any profit from the work, but does this to make the information contained in the large libraries with which it has connection available to every member. The rates are as follows:

Photo Print Copies of articles, drawings, etc., 25c per 10 x 14-inch sheets.
Searches, abstracts, etc., $2.00 an hour.
Translations, $6.00 per thousand words for French of German; $7.50 and upward for other languages.
Reference card service, giving reference to current magazine articles, $10.00 a year in advance, and 5c for each card mailed.

Members desiring to avail themselves of this service should address Library Bureau, American Society for Steel Treating, 4600 Prospect Ave., Cleveland, Ohio.

CASTING STEEL INGOTS CENTRIFUGALLY. By L. Cammen, in *Iron Age*, December 7, 1922.

This paper gives the results from using a horizontal bottleneck mold for centrifugally casting ingots and plate. It also compares this method with earlier processes. It shows the excellence of the ingots cast and gives their cost.

EQUILIBRIUM DIAGRAM OF THE IRON-CARBON SYSTEM. By Kotaro Honda, Bessemer Medalist, in *Chemical and Metallurgical Engineering*. Volume 27, No. 24, December, 1922.

The above is the sixtieth report, slightly abstracted, from the Iron and Steel Research Institute, Sendai, Japan.

In the diagram metastable or graphite lines are rejected, the solidus redrawn and A_4 or Delta iron fields are introduced. A_2 and A_0 represent no changes in phase, but are traced across the diagram.

EXPERIMENTAL PRODUCTION OF ALLOY STEELS. By H. W. Gillett and E. L. Mack, in *Journal* of Franklin Institute, Volume 194, No. 6, December, 1922.

The above is an abstract of notes from the U. S. Bureau of Mines.

The Bureau of Mines has prepared a number of series of alloy steels, containing such alloying elements as uranium, vanadium, tungsten, molybdenum, cerium, boron, and zirconium, alone and in various complex alloys. The steels prepared were studied with reference to the alloy recovery, the character and composition of the ingot, and their metallurgical behavior in the furnace. The Bureau of Standards and a number of commercial steel companies have co-operated in this work.

TOOL ENGINEERING. By Albert A. Dowd and Frank W. Curtis, President and Chief Engineer, Dowd Engineering Company, New York City, in *American Machinist*, Volume 57, No. 21, November, 1922.

This paper is the sixty-first installment of a series on tool design in which the subject of dies are treated.

Progressive piercing, blanking and double-bending dies are discussed.

DECARBURIZING FERROCHROMIUM BY HYDROGEN. By Louis Jordan and F. E. Swindells, Chemist and Assistant Chemist, Bureau of Standards, in *Chemical and Metallurgical Engineering*, Volume 27, No. 22, November, 1922.

Various tests have been made in connection with the preparation of this paper. These tests indicate that while the decarburization of ferrochromium by means of hydrogen takes place to some extent at temperatures below the melting point of the alloy, the most promising condition for refining high-carbon alloy by this method is probably by blowing the molten alloy with a blast of hydrogen in a converter.

ANNEALING OF GRAY CAST IRON. By Dr. E. Piwowarsky, of Breslau University in *Stahl und Eisen*, in September 28, 1922, republished in *Iron Age* Dec. 7, 1922.

The above paper gives the results in three tables of a German investigation of annealing tests on three grades of iron.

A PHYSICO-CHEMICAL INTERPRETATION OF THE EFFECT OF STRAIN UPON METALS. By C. Y. Yearsley, presented in October, 1920 before the Birmingham Metallurgical Society and published in the *Journal* of the Society in Vol. 8 No. 4.

This paper is the Students' Prize Paper and contains a review of the current literature on the effect of strain upon metals.

THE PROTECTIVE ACTION OF COPPER IN CASE CARBURIZING. By James C. McCullough (Associate Professor) and H. A. Holden Pray, of Severance Laboratory, Oberlin College, Oberlin, Ohio, in *Chemical and Metallurgical Engineering*. Volume 27, No. 23, December 1922.

The above paper shows the cause of failure in some cases and gives a reliable remedy.

When soft iron is heated in a charcoal pack, the carbon monoxide gas penetrates into the iron and gives up some of its carbon to the iron to effect the desired carburization. Carbon monoxide gas does not dissolve easily in copper and hence cannot pass through it unless there are cracks or holes in the copper. A thin copper plating over iron should, therefore, prevent carburization unless there are flaws in the copper.

The authors found flaws in every plating that they had examined that had failed to prevent carburization but no breaks were found in the effective platings.

STEEL. By Charles Rumford Walker. A book published by the Atlantic Monthly Press, Boston.

The author points out that in the great steel mills the 12-hour day and the 24-hour shift are still grim realities, but the men who toil there are not much given to analyzing their problems of living nor are they much gifted in the way of self-expression.

In STEEL, a college man who has worked as a clean-up in the pit, as helper on the open-hearth, and as hot flash man on the blast furnace, has raised a voice, not in plea nor in plaint, but in a straight broad shouldered story of his own life in the mills from day to day. It makes interesting reading from many points of view.

STANDARDIZATION OF SMALL TOOLS. By Carl J. Oxford, Chief Engineer, National Twist Drill & Tool Company, Detroit, Michigan, in *Mechanical Engineering*, November, 1922.

The above paper explains how the first cost of small tools can be greatly lowered, without sacrificing their efficiency, by the adoption of standards that will permit their manufacture on a quantity basis.

EFFECT OF MANGANESE ON CARBON STEEL. By Henry S. Rawdon and Frederick Sillers, Jr. in *Iron Age*, Nov. 23rd, 1922.

This paper shows how the structure of carbon steels is effected by varying percentages of manganese. While the results of the structure examination did not warrant any definite conclusion concerning the use of manganese as a strengthening element in steel, the results obtained, strongly supported previous recommendations which have been made by different metallurgists concerning the advantages to be gained from the use of higher manganese, particularly in lower and medium carbon steels.

An interesting application of a rather unusual alloy steel has come to light. In an address before the New York chapter of the American Society for Steel Treating, last week, a representative of one of the largest American companies producing steel castings and forgings for locomotive parts stated that his company is rapidly expanding its use of manganese-vanadium steel in forgings in place of plain carbon steel. The steel contains about 0.90 per cent manganese and 0.20 per cent vanadium. It has excellent physical properties, is superior to the plain carbon steel, lower in manganese than was formerly used, and is especially responsive to the heat treatment necessary for parts into which it goes. A similar steel, higher in manganese but without the vanadium, made a record during the war because of its unusual properties. Containing 1.25 to 1.50 per cent manganese, it must be regarded as an alloy steel. It is still in use, but its possibilities are not yet fully appreciated, thorough investigations of its behavior are actively in progress. With part of the manganese replaced by vanadium, this new alloy steel is an illustration of the many combinations possible and of the tendency of simple alloy steels to replace plain carbon steels.

DETERMINING COMBINED NITROGEN IN IRON AND STEEL. By Louis Jordan and F. E. Swindells, Chemist and Assistant Chemist, Bureau of Standards, in *Chemical and Metallurgical Engineering*, Volume 27, No. 23, December 1922.

The authors explain the Allen method for combined nitrogen and state that the usual method for the determination of combined nitrogen in steel is a modification of the Allen method.

They also point out the errors which result from the use of the Nessler method or rather the Nessler determination. Two tables are given showing the comparison of titration and Nessler methods as well as the comparison of methods of solution.

The paper finally explains the method for combined nitrogen which is used by the Bureau.

EQUIPMENT FOR MAKING DIE-CASTINGS. By A. G. Carman, Chief Metallurgist, Franklin Die-Casting Corporation, Syracuse, New York, in *Machinery*, December, 1922.

This paper is the first of a series of articles which points out the applications of die-castings; discusses the general principles of die-casting machines; and gives points on the design of parts to be die-cast.

The author is secretary of the Syracuse Chapter of the American Society for Steel Treating.

LAYOUT FOR ELECTRIC TOOL STEEL PLANT. By Merle W. Caruthers, Engineer, Westinghouse Electric & Mfg. Co., East Pittsburgh, in *Iron Age*, Nov. 23, 1922.

This paper gives a suggested plan which represents an idea for the layout of an electric tool steel plant. The author states that we are slowly realizing that the physical requirements of any tool steel are far more important than the chemical composition. It remains for some standard testing apparatus to be designed that will reveal the true requirements of tool steel and, until that time comes, our greatest safeguard against poor quality is by using steels that have been made by up-to-date manufacturers, using up-to-date methods and equipment and controlled by up-to-date supervision and design.

MANUFACTURE OF ALLOY STEELS FOR AEROPLANE SHAFTS. Abstracted from *Stahl und Eisen*, Jan. 8th, 1920 and May 20th, 1920 published in *Chemical and Metallurgical Engineering*, Vol. 27 No. 21, November, 1922, by Dr. E. Kothny.

The author recounts his experiments on the manufacture of nickel-chromium steel in the basic Heroult electric furnace and comes to the conclusion that in order to produce aeroplane shafts, with no trace of transverse structure, it is necessary to use very good raw material and refine with two oxidizing slags as well as the usual carbide slag.

ELECTRIC HEATING APPLIED TO THE STEEL INDUSTRY. By F. A. Hansen, Combustion Engineer, Westinghouse Electric & Manufacturing Company, East Pittsburgh, Pa., in *Journal* of the Association of Iron & Steel Electrical Engineers, November, 1922.

The author describes the various types of industrial heating appliances, low temperature ovens, electric furnaces, stating that the electric furnace has reached a stage where it may be assumed that it can be applied to practically any process now accomplished through fuel-fired furnaces.

Reviews of Recent Patents

1,423,361. Device for Producing Extruded Sheet Metal. Albert F. Rockwell, Bristol, Conn., assignor to Marlin-Rockwell Corporation, New York, a corporation of New York.

This invention relates to apparatus for reducing metal ingots to sheet form. It has been discovered that several steps can be dispensed with in the ordinary process of reducing the ingot to sheet form, thus reducing quite materially the most of production, and in addition produce a sheet metal having greatly improved characteristics with relation to the quality of the metal in the final product.

1,424,171. Machine for Manufacturing Tubing. Dwight B. Lee, Detroit, Mich., assignor to Motor Products Corporation, Detroit, Mich., a corporation of Michigan.

This invention relates to the manufacture of metallic tubing of that type in which the tube is first formed up from sheet metal with a locked seam, the seam being soldered to effectually seal the same.

1,424,483. Drilling Machine for Tapping out the Hot Metal of Furnaces and Cupolas. Joseph E. Judy, McKeesport, Pa.

The above invention contemplates the provision of a drilling machine adapted to be operated by fluid pressure and to be suspended from a jib crane or other movable supporting element and swung into position in front of the tapping hole and held there during the drilling of the hole.

1,424,595. Casting Machine. Paul E. Schwarz and Thomas D. Salmon, Philadelphia, Pa.

This invention relates to devices particularly designed for making dental and similar castings, and one object of said invention is to provide a simple, reliable, comparatively inexpensive device for causing air pressure to be applied to a body of molten metal, with a view to causing this to flow into a suitably positioned mold.

1,425,111. Alloy for use in Electric Heating Appliances. Geo. Harry Lofts, Hobart, Tasmania, Australia.

This invention relates to the manufacture of an alloy that was found especially useful in electric-heating appliances for the protection of same. In such appliances a fusible metal has been employed to cut off the power or current in order, for instance, to avoid over-heating.

1,425,499. Heat-Treating apparatus. Harry A. Lewis, Norristown, Pa.

In heat treating apparatus the combination of a furnace having a false bottom, a plurality of rows of slots formed in the said false bottom, shafts mounted beneath the said rows of slots and transversely to the individual slots, means for rotating the said shafts, and disks eccentrically mounted on the said shafts and adapted when the said shafts rotate to project up through the said slots and to directly engage and support the work during a portion of their movement, the

disks on each shaft being set alternately at two different angles on their shaft, and the disks on each shaft being staggered with relation to the disks on the adjoining shafts.

1,425,660. Furnace for the heat treatment of metals. Lyman C. Josephs Jr., Allentown, Pa., and Gottfried Wirrer, Plainfield, N. J., assignors to International Motor Company, New York City.

In a furnace for the heat treatment of metal, the combination of a series of heat treating stations, a carrier movable to transfer the article under treatment from one station to the next, a motor for operating the carrier, electrical connections through which the motor is operated intermittently and devices subject to a change in the rate of change of dimension of the article under treatment whereby the operation of the motor is initiated after each period of rest.

1,425,851. Metal-Treating Apparatus. John F. Gillan, Schenectady, New York, assignor to General Electric Company, a corporation of New York.

The invention comprises an improved apparatus for carrying out metal coating processes, and particularly the process known as sherardizing, which involves the surface alloyage of a metal with zinc.

1,427,121. Heat treatment of manganese steel. Wesley G. Nichols, Chicago, Ill., assignor to American Manganese Steel Company, Chicago, Ill.

The invention relates to an improvement in the art of heat treating manganese steel castings, which consists in subjecting such castings to heat, the maximum temperature of which never exceeds the critical temperature for such castings.

1,427,753. Method of annealing metal. Edward G. Budd and Joseph Ledwinka, Philadelphia, Pa., assignors to Edward G. Budd Manufacturing Company, Philadelphia, Pa.

The method of annealing metal which consists in enclosing the part to be annealed and removing therefrom the oxidizing effect of the surrounding medium, and including the same in series in the secondary circuit of an electrical transformer to heat the same to an annealing temperature, and finally cooling such part before exposure thereof to oxidizing influences.

1,430,948. Electrical Furnace for Treating Ores. Agamemnon Counas, Paris, France.

This invention relates to an electric furnace for treating ores, comprising a rectangular vat, a charging hopper above the vat, inclined electrodes on each side of the hopper and extending into the vat, the number of the said electrodes being determined by the length of the said vat, and a return electrode forming part of the hearth of the furnace, and arranged directly below the hopper.

1,435,211. Electric furnace. O. A. Colby, of Irwin, Pennsylvania, assignor to the Westinghouse Electric & Manufacturing Company of East Pittsburgh, Pa.

The invention relates to a crucible furnace, wherein the crucible is built up of alundum, sintered in place, resting on a resistor made of carborundum blocks. Current is led in by massive graphite blocks. Contacts at each end of the carborundum resistor are made by a packing of granular graphite, periodically replenishing that which is burned. The essential parts of the furnace are encased in refractory firebrick and insulating material, the whole bound with steel plates and mounted on trunnions.

News of the Chapters

SCHEDULED REGULAR MEETING NIGHTS

FOR the convenience of visiting members, those chapters having regular meeting nights are listed below. It is desired that all secretaries whose chapters are not included in the list should communicate with the National Office in order that the list may be as complete as possible.

Boston—Second Tuesday
Bridgeport—Thursday between 20th and end of month
Chicago—Second Thursday
Cincinnati—Second Thursday
Cleveland—Fourth Friday, Cleveland Engineering Society Rooms, Hotel Winton; meeting at 8:00 p. m.
Detroit—Second and fourth Monday. Detroit Board of Commerce.
Hartford—Friday nearest 10th of month
Indianapolis—Second Monday
Lehigh Valley—No regular night
New Haven—Third Friday
New York—Third Wednesday
Philadelphia—Last Friday
Pittsburgh—First Tuesday
Providence—No regular night. Nov. 10th, Dec. 12th.
Schenectady—Third Tuesday
Springfield—Third Friday
South Bend—Second Wednesday
St. Louis—Third Monday
Syracuse—No regular night
Tri City—Thursday
Washington—Third Friday
Rockford—Second Friday following the second Thursday

STANDING OF THE CHAPTERS

During the month of November, 73 new members were added to the Society as compared with 166 new members for the month of October. This increase in new members is a pleasing indication of the activities of the chapters, and while it is lower than the number obtained for October, it is realized that about 70 applications for membership were obtained at the annual convention. The 73 new members were distributed among 20 of the chapters, Detroit obtaining the largest number (16) while North West and Philadelphia obtained the second largest (9 each) and Chicago obtaining (8) of that number.

Detroit is still the largest chapter in the Society, having a lead of 46 members over its nearest competitor, Chicago. The standing of the chapters is as follows:

Those printed in capitals have advanced their position. Those

printed in italics have lowered their position from that published in the November report.

1. Detroit
2. Chicago
3. Pittsburgh
4. Philadelphia
5. Cleveland
6. New York
7. Hartford
8. Milwaukee
9. Boston
10. Lehigh Valley
11. NORTH WEST
12. **Syracuse*
13. **Worcester*
14. **Indianapolis*
15. *ST. LOUIS
16. *Rockford*
17. Tri City
18. *Cincinnati*
19. Buffalo

*=Tied

20. *Washington*
21. SCHENECTADY
22. **Springfield*
23. **Providence*
24. New Haven
25. South Bend
26. Toronto
27. Rochester
28. Bridgeport

*=Tied

Several suggestions have been received that some of the smaller chapters located in towns having a population of one hundred thousand or less, are not particularly interested as to the standing their chapters may have as compared with Detroit, Chicago, Pittsburgh and Philadelphia, and while it is realized that their point is well taken, and that under no conditions are the possibilities such that they would be able to rank first, second, third or fourth, nevertheless, it is felt, after giving the matter serious consideration, that it is advisable to continue the monthly report as to the standing of the chapters on the basis of membership. If any division is made, according to the population, it would be an injustice to some of the chapters having a large number of inhabitants whose industrial community is not as largely devoted to the iron and steel products as are the industries of a town of smaller number of inhabitants.

Thus it seems that inasmuch as the standing of the chapters is given only for a comparative basis and to create interest in the proximity of one chapter to another, it does not seem proper to undertake a classification according to population. The only justifiable re-arrangement would be in groups according to the industries and possibilities of the chapter in each city, and in order to do that it would be necessary to have a survey made of each city, which is more or less impossible.

Attendance Contest

The attendance contest does not begin until the December meeting and consequently no attendance percentage was possible for the January issue. However, the February issue will contain the percentage of members in attendance at the December meeting.

In this regard it is pointed out that the percentage of members in attendance is not based upon the number of members in good standing on Sept. 1, but is based upon the number of members in good standing on the first of EACH month. In other words, the percentage of members at the December meeting is not based upon the September number, but is based upon the number of members in good standing on Dec. 1.

The standing of the various chapters will then be considered on a basis of 50 per cent for attendance and 50 per cent for increase in membership. As an example, if a chapter had a percentage increase in membership of 46.2 per cent and an attendance percentage of 23.4 per cent, the total percentage 69.6 per cent would then be divided by 2, which would give the chapter a combined standing of practically 35 per

cent. All members of all chapters are urged to attend their regular monthly meeting, so that their attendance will count as an increase in percentage in the contest.

Increase in Membership

The National office has notified all of the chapter secretaries the number of members each had in good standing on Sept. 1, 1922 and has compiled from the monthly report sent to the local officers the new members the chapters have secured since that date up to Dec. 1, 1922 and has then figured the percentage of increase each chapter has had since Sept. 1. As an example, if a chapter had 90 members on Sept. 1 and gained during the months of September, October and November, 4 new members then the percentage increase would be 4.5 per cent, or, if the chapter had 25 members in good standing on Sept. 1 and during the interval up to Dec. 1 gained 6 new members, then their increase would be 24 per cent. The following shows the percentage of increase in membership on Dec. 1 over the chapter membership on Sept. 1, 1922.

	Per Cent		Per Cent		Per Cent
1. Detroit	46.2	10. New York	14.2	19. Pittsburgh	5.7
2. North West	28.3	11. Buffalo	12.5	20. Indianapolis	5.4
3. South Bend	24	12. Cleveland	10.8	21. Springfield	5.1
4. Schenectady	20.6	13. Chicago	9.7	22. Hartford	4.5
5. Milwaukee	18.3	14. Cincinnati	9	23. Syracuse	3.6
6. Boston	18.2	15. Washington	7.5	24. Toronto	3.6
7. Lehigh Valley	16.7	16. Worcester	7.2	25. Bridgeport	..
8. Philadelphia	15.5	17. Rockford	6	26. Providence	..
9. Tri City	14.6	18. New Haven	6	27. Rochester	..
				28. St. Louis	..

DR. ROSENHAIN TO TOUR AMERICA

THE eminent metallurgist, Dr. Walter Rosenhain, chief of the metallurgical department of the National Physical Laboratory of Great Britain and widely known for his capable research work, will tour the eastern part of the United States during February and March, 1923. On this tour he will lecture to various universities and educational institutions and technical societies.

The subjects of his lectures will be: The Structure and Constitution of Alloys; Aluminum Alloys; Hardness and Hardening; Strain and Fracture in Metals; Metallurgical Researches at the National Physical Laboratory.

"Solid Solutions" will be the title of the second annual lecture before the Institute of Metals Division of the American Institute of Mining and Metallurgical Engineering. This subject will deal with theoretical and fundamental principles.

He will deliver his lecture entitled "The Structure and Constitution of Alloys," before the Franklin Institute and will probably deal with the constitutional or equilibrium diagrams of alloy systems, their experimental determination and their interpretation.

It has not been definitely announced which of the lectures will be pre-

sented at the other meetings as listed below. For information in addition to this and pertaining to Dr. Rosenhain's visit may be secured from W. M. Corse, National Research Council, Washington, D. C.

Dr. Rosenhain's itinerary is as follows:

Lehigh University, Bethlehem, Pa., Feb. 14 to 16; Franklin Institute, Philadelphia, Feb. 15; American Institute of Mining Engineers, annual meeting, New York, Feb. 19 to 23, where he will speak at the banquet, Feb. 21, and deliver the second Institute of Metals lecture on Feb. 20 or 21; Columbia University, New York City, Feb. 23; Yale University, New Haven, Conn., Feb. 26 to 28; Waterbury, Conn., March 1 and 2; Providence, R. I., March 3; Massachusetts Institute of Technology, Cambridge, Mass., March 5, 6 and 7; Schenectady, N. Y., March 8 and 9; Rome or Corning, N. Y., March 10; Case School of Applied Science, Cleveland, March 12 and 13; Detroit, Mich., and Ann Arbor, Mich., March 14 to 19; University of Illinois, Urbana, Ill., March 20 to 22; Chicago, March 23 and 24; Toledo, O., March 26; Huntington, W. Va., (International Nickel Co.), March 27; Charleston, W. Va., March 28; Pittsburgh, March 29 and 30; Washington, D. C., March 31 to April 4 or 5; New Haven, Conn., dedication meeting of the American Chemical society.

INDUSTRIAL ENGINEERS ORGANIZED

AS ANNOUNCED in the current issue of *Gas Age Record*, several very definite undertakings for the industrial branch of the gas business have been outlined by the managing committee of the commercial section of the American Gas association. E. J. Stephany of the Equitable Gas Co., Pittsburgh, has been made chairman of the Industrial Gas committee, which may later be called the Industrial Gas division. The personnel of the committee, as just announced, includes many of the most prominent industrial gas engineers in the industry. They are:

N. T. Sellman, industrial engineer, A. G. A. Staff.
E. D. Milene, Consolidated Gas, Electric Light & Power Co., Baltimore.
W. T. Rasch, Consolidated Gas Co., New York.
H. H. Clark, Peoples Gas Light & Coke Co., Chicago.
F. F. Cauley, Peoples Gas Light & Coke Co., Chicago.
H. H. Smith, Boston Consolidated Gas Co., Boston.
H. O. Lobell, Combustion Utilities Corp., New York.
H. M. Henry, Combustion Utilities Corp., Toledo.
J. P. Lanroth, Public Service Co. of New Jersey, Newark, N. J.
John B. Allington, Rochester Gas & Electric Corp., Rochester, N. Y.
A. A. Schuetz, Milwaukee Gas Light Co., Milwaukee.
Robert E. Ramsey, the U. G. I. Co., Philadelphia.

Plans contemplate giving the committee ample time at the annual convention of the association for the discussion of the many problems confronting the industrial gas man today, when every indication is that soon the greatest outlet for the product of the gas plant will be for industrial uses. The committee will be allotted time for parallel sessions with the commercial section if necessary to cover the ground desired.

One definite aim of the committee for this year will be to try to interest

many makers of industrial equipment to exhibit at the annual A. G. A. Appliance and Equipment show and to encourage them also to display their apparatus and devices at other conventions where fuel and industrial process are considered. Several members of this committee are members of the American Society for Steel Treating.

BOSTON CHAPTER

The Boston chapter of the society held its regular December monthly meeting Thursday evening, December 14, at 7:30 p.m. in the Massachusetts Institute of Technology, testing material laboratory. Dr. G. B. Waterhouse, Professor of Metallurgy, formerly of the Lackawanna Steel Co., presented a very interesting paper entitled "Basic Open-Hearth Steel." Dr. Waterhouse's paper proved to be highly interesting and instructive and following it a lively and interesting discussion was held.

The laboratory of Professor Cowdrey and Mr. Homerberg were open for inspection, and members and guests were privileged in seeing many of the testing machines in operation, and also many samples of steel and photomicrographs of them were on display.

As evidenced by the large number of members and guests in attendance, this meeting was a decided success.

The January meeting will be held at the Blake & Knowles plant. The subject of the paper for this meeting will be "Forging." The plant of the Blake & Knowles company will be in actual operation, the exhibition will include the making of crank shafts and miscellaneous engine forgings, also the forging of Monel metal and bronze. A demonstration of the acetylene cutting torch and its advantages in forge practice will also be given.

CHICAGO CHAPTER

The Chicago chapter of the society held its regular meeting December 14, in the rooms of the Chicago City club, Plymouth Court and Jackson boulevard. The usual get-together dinner was served at 6:30 p.m. in the club rooms.

The program for this meeting was handled by three speakers.

Inasmuch as the Chicago chapter has used a novel method of announcing this meeting, we are publishing their program as they announced it in their leaflet, as it tells the whole story of their December 14, meeting. The announcement is a novel one and due credit should be given to the author of the idea.

AMERICAN SOCIETY FOR STEEL TREATING
CHICAGO CHAPTER

The Time

Thursday evening at 6:30 p.m. Dec. 14, 1922.

The Place

Chicago City club, Plymouth Court and Jackson Boulevard.

The Program

The next time your chairman rattles the bent spoon against the water

bottle, he will announce the subject of the evening to be none other than

How Would You Do It?

How would you do what? What would a steel treater naturally like to do? There are many things that steel treaters like to do, but there is one thing that every steel treater must do besides blame the steel for his troubles and that is heat his furnaces. He must therefore choose between gas, oil or electricity.

The presentation of this vital subject will be divided into three rounds of thirty minutes each.

At the sound of the first gong, W. P. Squire of the W. S. Rockwell Co., will tell us all there is to know about the use of oil for heat treating.

At the sound of the second gong, V. A. Hain of the George J. Hagan Co., will do likewise with electricity.

At the sound of the third gong, R. G. Guthrie of the Peoples Gas Light and Coke Co., will kick in with like information on the use of gas for heat treating.

Your committee can assure you that proper combustion will take place in each round without excess scaling, due to too much excess air. Mr. Hain on the electric end, don't use excess air so he must have something on Squire and Guthrie on that score.

Following the main bout there will be a catalytic discussion of same. Catalytic in that it will serve to jazz up many reactions in our minds and cause us to ask a multitude of questions.

Bring Your Appetites Along

Preceding the verbal barrage, dinner will be served at the City club, Plymouth Court and Jackson Boulevard, promptly at 6:30 p.m. There will be no baked ham and beans, but on the other hand there will be a real steak dinner with all the trimmings that Mr. Volstead will allow. The price of this feed will be the regular $1.25 per plate, your chapter absorbing the extra cost.

Reservations

Members are requested to send in their reservations cards at once as there will be big attendance. Otherwise they are going to have to eat by themselves.

CINCINNATI CHAPTER

The regular meeting of the Cincinnati chapter was held Thursday evening, Dec. 14, at 8:00 o'clock in the Ohio Mechanics institute, Canal and Walnut streets. The speaker for this meeting was Owen K. Parmiter, metallurgist, Firth-Sterling Steel Co., who presented a very capable paper entitled "Stainless Steel." Mr. Parmiter has presented this paper before several of the chapters and it has proved of great interest to all who have had the privilege of hearing him. There has been a great deal of interest shown in the rust-resisting steels and Mr. Parmiter handled his subject in a very capable way. A lively and interesting discussion followed this paper.

The January meeting of the chapter will be held on the eleventh of the month at which time W. R.Klinkicht, assistant engineer of tests, of the Pollak Steel Co., will present a paper entitled "The Forging of Large Sections." This paper will be illustrated with stereopticon views.

The February meeting will be held on the eighth of the month at which time, E. E. Thum, associate editor of *Chemical & Metallurgical Engineering* will present a paper entitled "The Relation Between the Management and the Metallurgist."

CLEVELAND CHAPTER

The Cleveland chapter of the society helds its regular monthly meeting on Dec. 20, at 8 p.m. in the Cleveland Engineering Societies rooms, Hotel Winton. The meeting was preceded by the usual get-together dinner which was served at 6:30 p.m. in the English room of Hotel Winton.

The chapter was particularly fortunate in being able to secure as speaker, Marcus A. Grossmann, metallurgist with the Atlas Steel Corp., Dunkirk, N. Y., and formerly with the United States bureau of standards who presented a very interesting and instructive paper entitled "Alloying Elements in Steel." Mr. Grossmann outlined in considerable detail the effects of varying quantities of the numerous alloys which are used in the manufacture of steel after suitable heat treatment had been given them as well as in their normal state. Mr. Grossmann developed his subject in a very clear and logical manner. A lively and interesting discussion followed the presentation of the paper.

One of the important matters which came before this meeting was that pertaining to a proposed bill for the licensing of Ohio engineers. This matter is receiving the careful attention of all engineers in the state of Ohio, inasmuch as two years ago a bill had been presented before the Ohio legislature and through the efforts of many of the engineers in the city of Cleveland and elsewhere in the state they succeeded in having the bill temporarily dropped inasmuch as they believed that it was not a bill which was for the best interests of all concerned.

Following a meeting of the Associated Engineering Organizations of Ohio, which was held in Columbus, O., Dec. 9, a questionnaire was prepared and sent out to all engineering organizations of the state. The questionnaire outlined three plans for registering engineers and it was requested that each engineering club, section chapter or society signify just how they would vote on any one or all of these plans.

Plan A. Provides for Compulsory Registration.

This plan is the one contained in the bill suggested by the Ohio Assembly A. A. E. and is a general bill to cover all engineers in the state in responsible charge of the design and construction of engineering work of a public or private nature which involves the public welfare, safety or health. The real intent of the plan is that all qualified and responsible engineers and surveyors in the state must or ought to be registered.

Plan B. Provides for Limited Registration.

This plan is the one contained in the bill suggested by the Council of Associated Technical Societies of Cleveland and is a special bill to cover only one class of engineers, namely, those employed by the state, countries, cities and other political subdivisions of the state. The real intent of the plan is, that all engineers other than those engaged on public work shall be exempt from registration but that the exempt ones may become registered if they so desire.

Plan C. Provides for Optional Registration

This plan is the one suggested at the meeting on Dec. 9 and is

an open bill to cover all engineers and surveyors in the state who desire to be registered of their own free will. The real intent of the bill is that no one must be registered. It is thought that if some engineers and surveyors become registered then in time all other engineers and surveyors will desire to be registered for reasons of professional pride and standing.

The chapter went on record as favoring plan B and instructed the secretary to advise the Associated Engineering Organizations of Ohio as to the manner in which the chapter has voted. The vote of the chapter will count as one ballot which will be considered together with those of the societies at the time of the executive committee meeting of the A. E. O. O. on Dec. 29. The result of this ballot will determine the future procedure of the A. E. O. O. in reference to the proposed bill for licensing engineers.

The legislative committee of the Associated Technical Societies of Cleveland of which the chapter is a member has drawn up a proposed Ohio registration bill for professional engineers and land surveyors which contains most of the provisions of the A. A. E. proposed bill but which eliminates the features that were objectionable to the Cleveland engineers. It provides for limited registration of engineers and the real intent of the plan is that all engineers other than those engaged on public work shall be exempt from registration but that the exempt ones may become registered if they so desire.

The entire matter is in the hands of the legislative committee of the Associated Technical Societies of Cleveland and the committee has been given full authority to act at such times as they are called upon.

DETROIT CHAPTER

The Detroit Chapter is going through a period of boom. No noisy revival is being raised. It is not artificial. Apparently no more efforts are used than usual, still the members are flocking to the meetings.

At the Nov. 27 meeting of the chapter E. J. Janitzky of the Illinois Steel Company read a paper on "Melting Practice, Open-Hearth, Bessemer and Electric. Mr. Janitzky made his paper especially interesting by illustrating the processes with motion pictures, taken at the Illinois Steel Company's plant.

The chapter had as its guest W. S. Bidle, second vice-president of the Society and Professor A. E. White, a member of the Board of Directors. These two members of the Board of Directors were present to discuss some matters pertaining to the local chapter, and the National Society in general.

The Detroit Chapter feels quite proud of the interest its members are taking in the Society's affairs. To further this, and to make the members better acquainted with each other, the chapter plans to have every second meeting connected with a supper, and all meetings will be held at the Board of Commerce as they were last year, where the members can enjoy a little more comfort, than in some of the meeting rooms in which they have had their meetings during the present year.

On Monday, Dec. 11 the chapter held a meeting in the Board of Commerce room at which time Earl C. Smith, metallurgist of the Cen-

tral Steel Company of Massillon, Ohio, presented his very capable paper entitled "Rolling Practice—Ingot to Finished Product." This subject has created considerable interest, and Mr. Smith presented his subject in a very capable manner. The paper brought out some very interesting and valuable discussion which was participated in by many of the members present.

Following the dinner which preceded the meeting, R. R. Plum was presented with a traveling bag as a token from the members of the chapter for his invaluable services during the convention when as a member of the financial committee he sacrificed many days to make the convention a financial success.

HARTFORD CHAPTER

The December meeting of the Hartford chapter was held Friday evening, Dec. 8, at 7:45 in the assembly hall of the Hartford Electric Light Co., Hartford, Conn. An informal dinner was served in the Young Men's Christian association cafeteria downstairs at 6:30 p. m. preceding the meeting, which was attended by a considerable number of members and guests.

The program for this meeting consisted of two papers, the first by G. C. McCormick entitled "Furnace Atmospheres and Their Relation to the Formation of Scale," and the second by E. L. Willson entitled "Synthetic Pig Iron."

The first paper described the experiments carried out at the Crompton Knowles Loom Works, Worcester, Mass., for the purpose of determining the conditions under which scale forms during the heat treatment of steel, and to determine methods of minimizing scaling. The subject of scaling steel has been a matter of considerable importance to steel treaters inasmuch as the scaling of finished tools is a very important and often times a serious proposition. Mr. McCormick's paper was very well presented and proved to be of extreme interest to all who were present, and developed a very lively and interesting discussion.

Mr. Willson presented his paper entitled "Synthetic Pig Iron" in which he gave a brief description of the conversion of steel scrap into pig or cast iron, as performed at the plant of the Connecticut Electric Steel Co. The process which he described is the reverse of that by which the original steel was made, and proved to be of particular interest because of the wide variety of compositions for special purposes which can be obtained by the electric furnace method of making cast iron. The discussion which followed Mr. Willson's paper was very instructive and interesting.

INDIANAPOLIS CHAPTER

The regular monthly meeting of Indianapolis Chapter was held Dec. 11 in the ald auditorium of Manual Training high school. The subject presented at this meeting was "Refining Steel by the Bessemer Process." This subject was presented in an excellent way by Mr. A. E. Crockett, of the Jones & Laughlin Co., of Pittsburgh. Mr. Crockett's paper covered the whole process from ore to finished product and was made more interesting by means of illustrations by lantern slides. Mr. Crockett's paper was one of the most interesting ever presented before Indianapolis Chapter.

The subject of the evening class in metallurgy held under the auspices

of the local chapter was brought up and enrollment was made. The classes are to begin Jan. 8 and will cover a period of 15 weeks, one night a week. Fifty-one enrolled at the meeting while several have signified their intentions to join before the next meeting. The course is under the direction of Mr. H. B. Northrup, metallurgist of the Diamond Chain & Mfg. Co., of Indianapolis. Mr. Northrup is especially well qualified to direct this course because of his extensive experience in the making of steel, having worked in all the different processes from mines to finished product and also because of his several years teaching experience on the same subject at Pennsylvania State college. The members of the local chapter will assist Mr. Northrup on special subjects.

The meeting was attended by approximately 85, including several visitors from out of the city. Col. A. E. White of the board of directors attended the meeting as well as an executive meeting held before the general meeting.

The next meeting of Indianapolis Chapter will be held at the Citizens Gas Co., where an inspection trip will be held. After seeing how gas and coke are made, a dinner will be held, probably at the Hoosier Athletic club.

LEHIGH VALLEY CHAPTER

The Lehigh Valley chapter of the American Society for Steel Treating held its December meeting on the 5th at 8:20 p.m. in the clubhouse of the Ingersoll-Rand Co. The program for this meeting consisted of moving pictures, the first set of which was entitled "The Story of Rock Drilling"—showing the various methods and types of drill used in the quarrying of rock. The second series of pictures was that of "The Rolling of Armco Iron" showing the entire operation of the manufacture of Armco Iron at the plant of the American Rolling Mills Co., Middletown, O. The third series was entitled "The Story of the Manufacture of an Automobile" which was taken at the plant of the Studebaker corporation, South Bend, Indiana, showing the entire manufacture of the Studebaker Co.'s Light-Six car. These pictures were indeed very interesting and were enjoyed by about 100 members and guests.

Prior to the exhibition of the moving pictures, a great many indulged in bowling on the alleys of the club room.

Preceding the meeting proper, the members of the executive committee assembled at the University club with Mr. J. J. Crowe, member of the national board of directors to discuss matters pertaining to the local chapter and the national society.

MILWAUKEE CHAPTER

The Milwaukee Chapter of the American Society for Steel Treating held its December meeting on Thursday evening, the fourteenth at eight o'clock in the Medford Hotel, 119 Third St., Milwaukee, Wis. The meeting was preceded by a get-together dinner which was scheduled for seven p. m. Following this dinner, H. G. Knowlton, Instructor in Metallurgy, Milwaukee Continuation School, presented his very capable paper entitled "Carburizing." Mr. Knowlton who is an authority on carburizing presented some very pertinent facts pertaining to the process of carburizing steels. His paper was indeed interesting and brought forth some valuable

information to steel treaters. Following Mr. Knowlton's paper an interesting discussion on carburizing followed.

NEW HAVEN CHAPTER

The New Haven Chapter of the Society held its December monthly meeting Friday evening Dec. 15, at eight o'clock in the Assembly Room of the New Haven Gas Light Company, 70 Crown St., New Haven, Conn. Due to the inclement weather a number of the chapter members were unable to attend, although a fairly large number of members and guests were there to greet the speakers of the evening.

The subject which had been selected for this meeting was the selection of fuel for industrial heating operations and two very capable men had been selected to present this subject. The speakers were J. A. Doyle of the W. S. Rockwell Company, New York City, who presented his paper entitled "Selection of Fuel for Industrial Heating Operations" and E. F. Collins of the General Electric Company, Schenectady, N. Y. who spoke on the subject "Electricity as a Fuel."

This meeting was one of the most enthusiastic ones that New Haven Chapter has ever had, and a great many questions were asked from the floor after the speakers had presented their papers. It was regretted that more of the members of the chapter were not able to be there but it was due entirely to the bad weather conditions which prevailed during the day and evening of this meeting. Those who were in attendance surely enjoyed a very entertaining and instructive evening.

The New Haven Chapter is taking an active interest in the membership and attendance prizes which have been offered by the National Board of Directors of the Society and they are bidding well to be one of the recipients of one of the prizes to be awarded after June 30, 1923.

NEW YORK CHAPTER

On Wednesday evening, Dec. 20, the New York chapter enjoyed a very interesting and instructive paper entitled "Case Hardening" by C. B. Callomon of the Driver-Harris Co., Harrison, New Jersey. Mr. Callomon's paper proved very interesting and was enjoyed by many members and guests of the chapter. Following the paper a lively discussion in reference to case hardening and carburizing was held. The meeting proved to be very entertaining and instructive to all who were present.

NORTH WEST CHAPTER

On Tuesday evening, Nov. 28, the North West chapter held a smoker in the rooms of the Manufacturers' Club of Minneapolis. This meeting was a get-together meeting. There was no specific program outlined, but this meeting was held to give the members an opportunity to meet their old friends and also to meet the newer members. The evening was devoted to good music, moving pictures, and various kinds of interesting entertainment. Refreshments were served and a goodly quantity of smokes were available.

This meeting was well attended and proved to be a decided success.

The North West chapter held a meeting on Tuesday evening, December 12, in the rooms of the Manufacturers' club of Minneapolis. J. Fletcher Harper, research engineer of the Allis-Chalmers Manufacturing com-

pany, Milwaukee, presented a paper entitled "Practical Experiences with Deep Etching and Annealing of Cast Iron and Forgings." Mr. Harper illustrated his paper with stereopticon slides. The speaker who formerly was assistant superintendent of forgings with the Allis-Chalmers Manufacturing company and who is now research engineer for the same company has had many varied and practical experiences which formed the basis of his paper. Mr. Harper pointed out the advantages of the deep etching method for the examination of material for machinery parts; and pointed out that defective material could be quite readily detected by this method of examination. The portion of his paper dealing with the annealing of gray iron castings proved of considerable interest to all, due to the fact that the ageing or annealing of iron castings is quite an important feature to be observed prior to the machining of parts such as pistons and cylinder-blocks inasmuch as many have found that in machining gray iron castings without annealing or ageing them, there has been caused untold trouble in the finished product due to the fact that the castings will not stay in shape. Mr. Harper presented some very valuable and interesting data on the subject.

PITTSBURGH CHAPTER

The regular monthly meeting of the Pittsburgh chapter of the society was held jointly with the American Institute of Mining and Metallurgical Engineers Tuesday evening, Dec. 5 in the Chatham hotel roof garden. I. J. Anderson of the United States bureau of mines, presented a paper on "Corrosion," which reviewed considerable of the work that the bureau of mines is doing on this particular subject. Mr. Anderson presented some very interesting facts with reference to the corrosion of metals and his paper was indeed interesting and instructive to all.

The second paper of the evening was presented by Prof. S. L. Goodale of the University of Pittsburgh, entitled "Metallurgical Education." The usual get-together dinner was served at 6:30 in the Chatham hotel.

PROVIDENCE CHAPTER

The Providence chapter held its December meeting in the fuel laboratory of the Providence Gas Co. This was the first meeting of the membership attendance contest. There were many prospective members among the 130 present.

The subject of the meeting was "The Proper Heat Treatment of High-Speed and Carbon Tool Sfeel" presented by Z. N. Sault of the New England Annealing & Tool Co.

Arthur H. Higgins, sales manager of the Providence Gas Co., also gave a short address on the subject of "Heat" bringing out the idea that heat was necessary to produce everything that we used either at home or in our industrial lives. He then told of the part that gas played in the production of this useful heat and the economy of fuel in first turning the coal into gas so as to get all the by-products such as ammonia, tar, perfumes, extracts, etc.

The meeting took the form of a demonstration and lecture, Mr. Sault first giving a demonstration of the proper method of hardening high-speed

steel using furnaces heated by gas furnished by the Providence Gas Co. and quenching the steel in oil.

He also made the Metcalf test to determine the best hardening temperature for a piece of 1.20 per cent carbon steel.

Both the demonstrations were highly successful.

The audience then retired to the lecture room where Mr. Sault explained more fully the methods he used and gave a lecture on steel, explaining many methods of heat treatment which he had found successful during his 30 years' experience at the fire.

The speaker then answered several questions and there was a lively discussion on some of the points brought out by his lecture.

Mr. Sault is one of the "Men at the Fire" as well as a successful business man and his talk was very helpful and educating to all present. This meeting will be followed next month by a talk on the proper use of pyrometers to be given by Mr. McCormick of the Crompton Knowles Co., of Worcester. The Providence Gas Co. further helped the success of the evening by furnishing smokes and refreshments.

SCHENECTADY CHAPTER

The Schenectady chapter of the society held a meeting on Nov. 21 at Union college at which time Mr. R. B. McColl, assistant general manager of the American Locomotive Co., presented a very interesting paper entitled "Relation of Steel Worker to the Management." Mr. McColl's paper proved to be very interesting and resulted in a lively round-table discussion following. There were about 60 members and guests present and everybody enjoyed themselves heartily.

SPRINGFIELD CHAPTER

Mr. E. E. Thum, associate editor of *Chemical and Metallurgical Engineering* addressed the chapter on Friday evening, Dec. 15, at 8 o'clock in the Chamber of Commerce building. The subject of Mr. Thum's paper was "Educating the Metallurgist and Management." The paper proved to be very interesting and was a very capable presentation, as Mr. Thum has had many years of experience in industrial problems and has been associated with both phases of his subject for many years. A very interesting and instructive discussion followed his presentation.

WORCESTER CHAPTER

The Worcester chapter of the American Society for Steel Treating held its December meeting, Thursday evening, the fourteenth in the Electrical Lecture room at the Worcester Polytechnic Institute, Salisbury street, Worcester, Mass. The paper for this evening entitled "Educating the Metallurgist and the Management" was presented by E. E. Thum, associate editor, *Chemical & Metallurgical Engineering*. Mr. Thum presented his paper in a very entertaining and capable manner and it proved to be of extreme interest to all those who were present. This meeting was a joint meeting with the Worcester section of the American Society of Mechanical Engineers.

ST. LOUIS CHAPTER

The St. Louis chapter of the American Society for Steel Treating held its December meeting on the eighteenth at 8 o'clock in the American Annex hotel. The speaker for this evening was Ellis M. Johnston, district manager of the American Rolling Mill Co. of Middletown, O. His paper entitled, "Manufacture of Armco Ingot and Special Steel," was illustrated with three reels of moving pictures, taken at the plant of the company Mr. Johnston represents. These pictures show the manufacture of the product of the American Rolling Mill Co., from the ore to the finished product. Mr. Johnston presented his paper in a very capable and interesting way.

Prior to the meeting proper, a get-together dinner was served at 7 o'clock in the rooms of the American Annex hotel.

SOUTH BEND CHAPTER

The December meeting of the chapter was held at the Hotel LaSalle. Dinner was served at 6:30 p.m. at the College Inn, Hotel LaSalle to 27 members and guests. Following the dinner those present, needing a walk to settle their meal, walked up two flights of stairs to the meeting room.

Announcement was made that the speakers for the January, February and March meetings had been arranged.

A very interesting discussion was held on W. J. Harris' paper entitled "Some Factors Governing the Machineability of Steel," read at the November meeting.

W. F. Newhouse, a member of the chapter, read a paper on the subject "Heating Carbon Steel Parts—Lead Bath Method."

A very lengthy discussion was held on this paper, which was very interesting and instructive.

Everyone present at this meeting seemed full of questions and subjects for discussions, therefore, making it very interesting.

SYRACUSE CHAPTER

The Syracuse chapter of the American Society for Steel Treating held its December meeting Friday evening, Dec. 8, at the Chamber of Commerce. The meeting was preceded by a dinner which was served at 6:15 p.m.

The speaker for this meeting was Franklin Shepherd who presented a very capable paper on "Carburizing." There were about 75 people present at this meeting and all enjoyed an interesting and instructive evening. Following Mr. Shepherd's paper a lively and profitable discussion was held.

TRI-CITY CHAPTER

The regular monthly meeting of the Tri-City chapter of the Society was held Dec. 14 at the Davenport Chamber of Commerce. The meeting was preceded by a get-together dinner served at 7 p. m. About 35 were in attendance at the dinner.

The meeting was called to order at 8 p. m. by the chairman.. The chairman reminded the membership that the Membership and Attendance contest among the various chapters was now going on and urged the

members to bring in new members and to attend meetings regularly. The chairman then turned the meeting to Mr. A. H. Putman for a round table discussion on carburizing. Thirty minutes was allotted for this discussion.

The chairman then introduced the speaker of the evening, S. C. Spalding, metallurgist, with the Halcomb Steel Company, Syracuse, New York, who presented a paper entitled "WHY DID IT BREAK." Mr. Spalding gave a talk which covered the results of many years of experience in determining how and why steel parts fail in service. Mr. Spalding emphasized the necessity of co-operation between the steelmaker, the designer, the metallurgist, the fabricator, and the hardener. He showed the ill effects of sharp corners and sharp changes in sections. He pointed out the failure which might occur through too rapid or non-uniform heating and irregular cooling in the hardening operations. He pointed out the necessity of heating slowly, uniformly, and thoroughly. Mr. Spalding also pointed out characteristic defects which might occur in the grinding operation which frequently follows hardening. He gave a method for determining whether or not the failure was caused by the grinding.

In the discussion which followed the paper, questions were asked as to whether some of the characteristic defects might not be due to the cooling rather than to improper heating. Mr. Spalding replied that the failure might have been due to either cause.

A rising vote of thanks was tendered to Mr. Spalding for his excellent paper.

The chairman announced that the next meeting would be held on Thursday, Jan. 18, 1923 and that Mr. J. P. Gill, metallurgist with the Vanadium-Alloys Steel Company would speak on the subject of high-speed steel.

The meeting adjourned at 10:15.

TORONTO CHAPTER

Renewed activity and outstanding interest marks the rapid advancement of the condition of the Toronto Chapter.

A recent re-organization has been effected, whereby Colin C. Rous has been elected to the chairmanship of the chapter, while H. E. G. Watson, Supt. of the Industrial Division of the Consolidated Gas Company has accepted the position of Secretary-Treasurer.

An executive committee of five prominent men in the city have accepted their appointments, and are holding meetings regularly in order to arrange and divide the program that will meet with the greatest amount of interest from the membership.

Marcus A. Grossmann, metallurgist of the Atlas Steel Corp., Dunkirk, N. Y. addressed the first meeting of their chapter on Nov. 24, in the offices of the Consolidated Gas Company.

Mr. Grossmann used as his subject, an illustrated lecture on alloy steels, and presented the subject in such an interesting and entertaining manner that all of the large number present were very favorably impressed with the speaker and obtained an excellent insight to the manufacture of alloy steels.

The chapter is looking forward to a very interesting and enlightening series of meetings during the coming winter, and there is no doubt that

the hopes of the newly-elected officers will be fully realized in having a successful year.

WASHINGTON CHAPTER

The Washington Chapter held its November meeting on the night of Nov. 24, at which time W. R. Shimer, metallurgist of the Bethlehem Steel Company gave a very interesting paper on the manufacture of steel. Mr. Shimer's paper was illustrated with stereoptican slides and traced the manufacture of steel from the ore bed to the finished product.

Following Mr. Shimer's paper, J. E. Howard, engineer-physicist of the Bureau of Safety of the Interstate Commerce Commission remarked that experience in the behavior of steel has shown at times a close approaca to the limit of ultimate endurance of the metal. He stated that steel rails in railway service afford illustrations of this kind, demanding, if obtainable, an advance in the ability of the rails to meet the conditions which are imposed upon them. He pointed out that it was a controversial point between steel makers and railroad engineers as to whether the limits of the endurance of steel are really being reached, or whether the grades of steel put out by the steel mills are responsible for the failure of the rails to endure track and service conditions.

Mr. Shimer's paper raised many points for discussion and proved to be an interesting subject and was enjoyed by all those that were in attendance.

The December meeting of the chapter was held Wednesday, Dec. 20, in the auditorium of the New Interior Department Building, corner Eighteenth and F Sts., N. W., at which time B. F. Shepard, Asst. Supt. of heat treating, Ingersoll-Rand Co., Phillipsburg, N. J., presented a verp capable paper entitled "Carburizing." The subject of carburizing for case-hardening has long been a topic of intense interest to steel treaters, inasmuch as there are so many factors which enter into the production of a satisfactory and serviceable finished product.

Mr. Shepard has had wide experience in this work at the plant of the Ingersoll-Rand Co., having specialized in the field of carburizing and case-hardening, and he presented some very interesting and pertinent facts pertaining to the proper carburizing of steel. Mr. Shepard's paper brought out considerable interesting and very instructive discussions, which proved to be of interest and benefit to all.

ADDRESSES OF NEW MEMBERS OF THE AMERICAN SOCIETY FOR STEEL TREATING

EXPLANATION OF ABBREVIATIONS. M represents Member; A repesents Associate Member; S represents Sustaining Member; J represents Junior Member, and Sb represents Subscribing Member. The figure following the letter shows the month in which the membership became effective.

NEW MEMBERS

ANDERSON, E. E., (M-11), 4724 Hastings Street, Detroit, Michigan.
ANDERSON, H. E., (M-12), 917 11th Street, Rockford, Ill.
ANDERSON, K. G., (M-11), J. L. Clark Manufacturing Company, Rockford, Illinois.
ARMSTRONG, G. J., (M-12), Columbus McKinnon Chain Co., Tonawanda, N. Y.
AYLING, JAS., (A-6), Case Hardening Service Co, Cleveland, Ohio.
BABCOCK & WILCOX CO., (S-11), 85 Liberty Street, New York City.
BEAUVAIS, P. J., (M-12), 5649 Eldred Street, Detroit, Michigan.
BERRY, T. J., (M-11), 2904 Mishawaka Avenue, South Bend, Ind.
BETHLEHEM STEEL CO., (S-12), Sales Department, Bethlehem, Pa.
BOWMAN, H. V., (M-12), 3640 34th Ave. S., Minneapolis, Minn.
BOYD, CHAS. F, (M-12), Nordyke & Marmon Co, Indianapolis, Ind.
BRADLEY, W. M., (M-12), 1404 North 62nd St., Philadelphia, Pa.
BRAY, H. M., (A-12), Colonial Steel Co, Pittsburgh, Pa.
BRICKNER, CAPT. L. M., (M-12), Aberdeen Proving Grounds, Aberdeen, Md.
BUCHER, F., (M-11), 711 Park Avenue, Dunkirk, N. Y.
CALEF, J. F., (M-11), 1001 W. Van Buren St., Chicago, Ill.
CANDEE, H. M., (M-12, 17 Wood St., Union City, Conn.
CARBAUGH, PHILIP, (M-12), 849 N. Court St., Rockford, Ill.
CHAWNER, G. F., (M-12), 605 Wethersfield Ave., Hartford, Conn.
COUNSINS, H. G., (M-12), 5299 Ivanhoe Ave, Detroit, Mich.
CRAN, JAMES, (M-12), 30 Glenwood Road, Albany, N. Y.
DAVIS, W. E., (M-12), 2462 Grand Blvd. W., Detroit, Mich.
DERR, A. G., (Jr-12), 1734 N. 15th St., Philadelphia, Pa.
DEUTSCHE, WM., (A-12), 519 Masonic Temple, Minneapolis, Minn.
DICKENS, A., (M-12), 5146 E. St. Clair St., Indianapolis, Ind.
DOWNS, F. R., (M-11), New Britain Machine Co., New Britain, Conn.
DREW, E. G., (M-11), Y. M. C. A., Moline, Ill
EADS, G., (M-12), 8050 Sprague Ave., Detroit, Mich.
EMMERT, R. J., (M-11), Remy Electric Co., Anderson, Ind.
FIRTH & SONS, LTD., THOS., (Sub-12), Publicity Dept. Norfolk Wks., Sheffield.
GODDARD, A. N., (M-11), 4727 Hastings St, Detroit, Mich.
GOGGINS, T. L., (M-11), 157 Clinton St., Schenectady, N. Y.
GREEN, M., (M-12), King Sewing Machine Co, Buffalo, N. Y.
GROFF, R., (S-12), S. S. Fretz, Jr., & Co., 23rd and Sedgley Ave., Philadelphia, Pa.
GUSTAFSON, C. A., (M-11), 23rd and University S. E., Minneapolis, Minn.
HAAG, W. B., (Jr-11), Montgomery Co., Philadelphia, Pa.
HARDING, W. S., (M-12), 311 Gerling St., Schenectady, N. Y.
HAUVER, A. N., (M-12), 6 Ashland St., Everett, Mass.
HAWKRIDGE, C. F., (A-11), 313 Congress St., Boston, Mass.
HEDGES, E. P., (A-11), 827 Elmwood Ave., Evanston, Ill.
HEISE, A. R., (M-12), New Departure Mfg. Co., Bristol, Conn.
HELRIGEL, F. H., (M-12), Motor Products Corporation, Detroit, Mich.
HOCKER, JOHN, (M-11), 522 Ave. H, Bethlehem, Pa.
HOWELL, WM. L., (M-12), Box 176, Midland, Pa.
JAMISON, J. F., (Jr-12), 204 Broad St., Philadelphia, Pa.
JOHNSON, A. R., (M-11), 1720 8th St., Rockford, Ill.
JOHNSTON, G. D., (M-12), 523 Hight St., Easton, Pa.
JOLLY, J. J., (M-12), 127 S. Salford St., Philadelphia, Pa.
JOSEPH, T. L., (M-11), U. S. Bureau of Mines, University of Minn., Minneapolis.
KASEY, JOHN (M-11), New Departure Mfg. Co., Bristol, Conn.
KENT, FRANK E., (M-12), 101 N. Virginia Ave., Atlantic City, N. J.
KELLEY, F., JR., (S-12), Peerless Belt Lacing Machine Co., Philadelphia.
KERR, JAMES F., (M-12), 69 Bristol St., Springfield, Mass.
KEWLEY, WM. C., (A-12), 506 Perry-Payne Bldg., Cleveland, Ohio.

KIRKPATRICK, T. L., (A-11), Wheelock, Lovejoy & Co., Cambridge, Mass.
LUTTS, F. C., (M-10), 3657 Vandyke Ave., Detroit, Mich.
MALONY, R. A., Jr., (Jr-12), 838 E. Price St., Germantown, Pa.
MANIER, R. L., (A-12), 205 Lillian St., Syracuse, N. Y.
MARSHALL, S. J., (A-12), Endicott Forging & Mfg. Co., Endicotte, N. Y.
MARTIN, F. P., (M-9), 530 Josephine St., Detroit, Mich.
MATHEWS, S. B., (Jr-11), 833 Wynnewood Road, Philadelphia, Pa.
McCLUNG, H. F., (M-10), 12853 Terry Blvd., Strathmoor, Detroit, Mich.
MERRICK, A. W., (M-11), 111 1st St., Scotia, N. Y.
MILLER, R. W., (M-12), 409 Wilbraham Rd., Springfield, Mass.
MOTT, H. S., (A-12), 216 W. Borden Ave., Syracuse, N. Y.
NELSON, W. E., (A-12), Firth Sterling Steel Co., Los Angeles, Cal.
NIEDRINGHAUS, G. H., (S-12), National Enameling & Stamping Co., Granite City, Mo.
O'BRIEN, T. S., (M-11), 17 Bedford Rd., Schenectady, N. Y.
ORAM, R., (A-11), 69 Carroll St., Buffalo, N. Y.
PARKER, S. W., (A-12), 127 Sidney St., Cambridge, Mass.
PARSONS, L. G., (M-12), 80 South St., Bristol, Conn.
PATRICK, J., (M-12), R. F. D. No. 1, Redford, Mich.
PERFECTION TOOL HARDENING CO., (S-11), 1229 S. State St., Chicago, Ill.
PFEIL, WM., (M-11), 813 South Bend Avenue, South Bend, Indiana.
PRETZ, C., (M-12), Studebaker Corporation, South Bend, Ind.
RAMSAY, GEO., (M-12), 707 Nott St., Schenectady, N. Y.
RAUCH, A. E., (M-11), Cutler Hammer Mfg. Co., Milwaukee, Wis.
REASONER, C. M., (M-10), 303 Walnut St. S. E., Minneapolis, Minn.
REITER, I. S., (Jr-11), 521 N. Ave. E, Bethlehem, Pa.
RICH, J., (Jr-12), 5129 Harlan St., Philadelphia, Pa.
ROFF, E. L., (M-12), 123 S. 11th St., Newark, N. J.
ROGLIN, E. C., (M-12), 10011 Parkgate Ave., Cleveland, Ohio.
SCHOEBERLEIN, GEO. A., (M-12), 906 Kirkpatrick St., Syracuse, N. Y.
SHELBY, J. B., (S-12), Driver-Harris Company, Harrison, N. J.
SHEPARD, G. V., (M-12), 757 Broad Street, Meriden, Conn.
SIGGELKO, W., (M-11), 1314 Logan Ave. N., Minneapolis, Minn.
SNYDER, P. M., (M-12), 1811 E. Main St., Massillon, Ohio.
STOKES, T. F., (A-11), 2 Foster St., Brookline, Mass.
TAPPER, G. W., (A-12), 413 Seitz Bldg., Syracuse, N. Y.
THOMAS, C. P., (M-9), 1107 Lee Street, Lansing, Mich.
THORP, F. Q., (A-12), 1131 Guardian Bldg., Cleveland, Ohio.
TRUEG, CHAS., (A-12), Pittsburgh Instrument & Mach. Co., Pittsburgh, Pa.
UNIVERSITY OF MINNESOTA (M-10), Minneapolis, Minn.
VOSS, T. H., (A-12), 4721 Pabst Ave., Milwaukee, Wis.
WESLEY STEEL TREATING COMPANY, (S-12), 651 S. Pierce St., Milwaukee, Wis.
WILLETT, G. H., (S-12), Standard Fuel Engr. Co., Detroit, Mich.
WIRZ, A. H., (S-12), A. H. Wirz, Inc., Chester, Pa.
WYMAN, L. L., (M-12), 713 7th Ave., Minneapolis, Minn.
ZABEL, GEO. W., (M-12), Fairbanks, Morse & Co., Beloit, Wis.

CHANGES OF ADDRESS

BACH, A. D., Jr., from Atlas Steel Corporation, Hanna Bldg., to Atlas Steel Corporation, 725 St. Clair Ave., Cleveland, Ohio.
BERMAN, I., from 72 Farmington Ave., to 133 Boulevard, Hartford, Conn.
CARTER, H. G., from Prospect St., Orange, to 65 Harding St., W. Newton, Mass.
CHERRY, R. M., from Nott St., Schenectady, to 103 N. 50th St., Philadelphia.
COBLE, C. C., from Charles St. to 522 Longwood St., Rockford, Ill.
CROSBY, V. A., from Lincoln St. to 630 N. Walnut, South Bend, Ind.
CUENOT, P. A., from American Locomotive Works, Schenectady, to 2018 N. 3rd St., Harrisburg, Pa.
CULLEN, J. F., from Delevan Ave., Buffalo, to Union Electric Steel Co., Carnegie, Pa.
DORSAM, A. J., from Water St. to 1813 E. Hagert St., Philadelphia, Pa.
FALES, H. G., from Highland St., W. Newton, Mass., to Emmons Apts., Huntington, W. Va.
HARDER, O. E., from University Ave. to 208 Cecil St., Minneapolis, Minn.

HICKOX, W., from 10th Ave., Rockford, Ill., to 743 32nd St., Milwaukee, Wis.
HILLMAN, S., from 6th St. to 1219 10th St., Rockford, Ill.
HODGEON, H., from Dale Ave., Muskegon, to 15141 S. Marshfield Ave., Harvey, Ill.
HOGAN, E. J., from Hughes Tool Co. to 2609 N. Main St., Houston, Tex.
HORN, D. H., from Vanadium Bldg. to Mesta Machine Co., Pittsburgh, Pa.
HUGHES, J. O., from Michigan Ave. to 114 E. Broadway, South Bend, Ind.
ILLNER, G., from Illinois St. to 3050 Lenox, Detroit, Mich.
IRONS, W. V., from Univ. of Buffalo to 3425 Main St., Buffalo, N. Y.
JACKMAN, A., from Mo. Athletic Assn., to 831 Westgate Ave., St. Louis, Mo.
JOHNSTON, W. E., from Quincy St. to 2624 Lyndale Ave., Minneapolis, Minn.
KERSLAKE, R. E., from Stop 7 to 19551 Euclid Ave., Euclid, Ohio.
KNAPTON, F. N., from Wilbraham Rd. to 48 Dearborn St., Springfield, Mass.
KOEPPEN, E. W., from Adams St., Chicago, to 651 11th St., Milwaukee, Wis.
LANNING, I. A., from New Departure Mfg. Co., Bristol, to 76 Franklin St., Meriden, Conn.
LARAWAY, W. P., from Sargent St. to 39 Maplewood Ave., Hartford, Conn.
LINCOLN, T. J., from Spring St., Meriden, to 59 Judd St., Bristol, Conn.
LUEBKE, O., from Clinton St. to 924 Pennoyer St., Grand Haven, Mich.
MAHONEY, J. D., from Hamilton St. to 11 Iowa St., Dorchester, Mass.
MARLOWE, J. S., from 7 Mayflower Apts. to Box 1173, Indianapolis, Ind.
MAYER, R. W., from Reliance Bank Bldg., Cleveland, to Brown Instrument Co., Ford Bldg., Detroit, Mich.
MENGES, L. A., from Lafayette Motors Co., Indianapolis, to Lafayette Motors Co., Milwaukee, Wis.
MIRZYEUSKI, J. A., from 23rd Ave., Milwaukee, to 4800 Beloit Rd., West Allis, Wis.
PIERCE, P., from Ruckle St. to 3821 E. Washington, Indianapolis, Ind.
REMINGER, G. E., from Ludlum Steel Co. to 3128 E. 99th St., Cleveland, O.
RICHARDSON, S. A., fromMadison and Robey Sts., Chicago, to University of Minnesota, Minneapolis, Minn.
RIEGER, W. H., from Donaldson Rd., Buffalo, to Union Elec. Steel Co., Carnegie, Pa.
ROBINSON, J. W., from C. H. Wills & Co., Marysville, to 309 W. Grand Blvd., Detroit, Mich.
SARGENT, J. F., from Ward St. to 131 Church St., Wallingford, Conn.
SCHMID, M. H., from 11th St. to 1303 Market Ave., Canton, Ohio.
SIKOROVSKY, F. G., from Springfield Ave., Chicago, to 2103 S. 62nd Court, Berwyn, Ill.
SIMMONS, C. F., from Latrobe Elec. Steel Co. to 25 B-Way, Room 2242, New York City.
STARKEY, F. H., from Whitney Mfg. Co. to 94 Warrenton Ave., Hartford, Conn.
STARY, L. G., Jr., from W. 90th St. to 3345 Fulton, Cleveland, O.
STRANAHAN, L., from Cleve. City Forge & Iron Co. to 1131 E. 145th St., Cleveland, Ohio.
SWART, C. A., from University Ave. to 142 Mildred Ave., Syracuse, N. Y.
TAYLOR, L. E., from 6th St. to 1131 Fairview Ave., Rockford, Ill.
TRICK, W. A., from Stanley St. to 680 W. Main St., New Britain, Conn.
TURNQUIST, E., from Miami St., Wabash, to 332 W. 9th St., Anderson, Ind.
WEBER, J. E., from P. O. Box 899 to 709 6th Ave., New York City.
WOODWARD, A. F., from Kinsman Rd., Cleveland, to 30 Burtt St., Lowell, Mass.

EMPLOYMENT SERVICE BUREAU

The employment service bureau is for all members of the Society. If you wish a position, your want ad will be printed at a charge of 50c each insertion in two issues of the Transactions.

This service is also for employers, whether you are members of the Society or not. If you will notify this department of the position you have open, your ad will be published at 50c per insertion in two issues of the Transactions. Fee must accompany copy.

Important Notice.

In addressing answers to advertisements on these pages, a stamped envelope containing your letter should be sent to AMERICAN SOCIETY FOR STEEL TREATING, 4600 Prospect Ave., Cleveland, O. It will be forwarded to the proper destination. It is necessary that letters should contain stamps for forwarding.

HELP WANTED—MALE

ASSISTANT METALLURGIST

For large MANUFACTURING ORGANIZATION. Necessary qualifications are, wide experience in METALLURGY, EXECUTIVE ABILITY AND PLEASING PERSONALITY. In reply give outline of experience, age, nationality and salary desired. Address METALLURGIST, 810 Broad St., Newark, N. J.

POSITIONS WANTED

WANTED—Position as Department Foreman in Heat Treating or Supervisor of Furnace Erection. Have had eight years experience with large firms and am anxious to be located with some firm where efforts to advance will be thoroughly appreciated. Address 12-25.

SUPERINTENDENT or GENERAL FOREMAN of heat treatment department. Experienced in all classes of carbon and high-speed tools and small forgings in quantity in coke, oil, gas or electric furnaces. Shore, Rockwell and Brinell hardness tests. Technical graduate. 15 years experience. Married. Address 12-5

METALLURGIST or CHEMIST. Exceptionally good experience together with a record of absolute satisfaction. Available at once. Eastern location preferred. Address 10-5.

CHEMIST and HEAT TREATER. Technical graduate. Experience in chemical, physical testing and heat treating of steels. Eastern location preferred. Reasonable salary. Address 10-10

POSITION WANTED IN HEAT TREATING LINE. Applicant has had six years experience as foreman in carburizing and can present the best of recommendations. No particular choice as to location, although prefer a position in the vicinity of Cleveland. Address 1-5.

POSITIONS WANTED

METALLURGIST—desires position. Experienced and technically trained in chemical analysis, physical testing, microscopic work and heat treating of carbon and alloy steels. Address 11-5.

METALLURGIST—1916 Graduate with six years experience as chief chemist and chief metallurgist. Thoroughly familiar with ferrous and non-ferrous analysis, metallurgy, metallography and physical treatment. Has had also good production experience, having had charge at Steel melting and heat-treating departments. During past year has been metallurgist for a Government Arsenal, in charge of ferrous and non-ferrous research and testing. Available at once. Address 1-10.

GRADUATE CHEMIST who has had several years experience in metallurgical analysis, analysis of iron and steel, etc. His work will be for the present, at least, wholly analytical. Address 10-20.

POSITIONS OPEN

YOUNG MEN—High grade to travel through the great manufacturing and industrial districts to install, inspect and test electrical instruments and temperature controlling equipment; special consideration will be given to applicants having had experience in handling instruments, meters, gauges, recorders, controllers, etc.; educated men preferred; unusual chance for promotion; write, stating experience, education, age and salary desired. Address 12-20.

FOREMAN to take charge of hardening department in plant in east. Must be able to harden tools, such as broaches and reamers and carbon and high-speed stee as well as case hardening. Address 12-1.

UNUSUAL opportunity to secure exclusive sales agency for tool steel mill in Detroit and Los Angeles districts. Mill long established and products of proven quality. Would require experience in selling steel and moderate capital. Address 9-15.

WANTED A MAN—to take charge of heat treating department in an eastern city. An expert metallurgist is not a requirement for this position but a man who is familiar with carburizing and general heat treatment routine. Address 11-15.

WANTED—Metallurgist with mature experience in the melting and casting of nickel-chromium alloys. Permanent position offered by established concern. Erecting new plant shortly. Address 11-20.

ANALYTICAL CHEMIST thoroughly familiar with the analysis of steel and steel works materials. Write, stating age, experience and salary required. Address 10-15.

Commercial Items of Interest

ARTHUR L. COLLINS, for the past six months associated with the Standard Steel and Bearings, Inc., has entered the tool and alloy steel department of Horace T. Potts & Co., Philadelphia, as sales metallurgist. His work will be with the various mills turning out the Potts' brands of steels and with the users of these steels in advising on applications and heat treatments.

Mr. Collins started as Philadelphia salesman of machine tools for Vandyck Churchill Co., New York, entered Stevens Tech and graduated with degree of M. E. in 1914. He was with Atlas Ball Company as engineer of tests and metallurgist until 1920.

In 1920 he was personally employed in promotion work, in writing for

ARTHUR L. COLLINS

the technical press, and in expert advisory service to a number of concerns.

In 1921 he was metallurgist for Ace Motor Corporation.

He is instructor and lecturer in metallurgy and metallography at Temple University.

He has been Secretary and Treasurer of the Philadelphia Chapter of the American Society for Steel Treating since its inception.

The special apparatus which has been developed at the Bureau of Standards, for testing the corrosion of steels by alternate immersion and exposure to the air is now perfected so that as soon as the different specimens have been properly heat treated, polished, measured, and weighed, the actual immersion tests can be started. A few preliminary tests which have been carried out indicate that the results will be obtained much more quickly by the method of repeated immersions than by simple immersion.

A new and useful improvement in the manufacture of open-hearth steel has been patented by Herbert C. Riding and W. Allen of Birmingham, Alabama. The invention aims to provide a process of making basic open-hearth steel from a charge which uses all blown metal, as distinguished from previous processes in which a certain quantity of scrap has generally been used as a part of the charge.

The Cleveland Twist Drill Co. announce the retirement on November 1 of E. G. Buckwell as secretary and sales manager following 23 years of active service. Mr. Buckwell will, however, remain a director and retain his interests with the company. W. E. Caldwell, who has had twenty-one years' experience in sales work with the company, has been promoted from the position of assistant sales manager to that of sales manager.

Marcus A. Grossman has been appointed metallurgist of the Atlas Steel Corporation, a consolidation of the Electric Alloy Steel Co. and the Atlas Crucible Steel Co. His new headquarters are in Dunkirk, N. Y.

Frank Nickerson, for 9 years connected with the San Francisco office of the Midvale-Cambria Steel Co., has severed his connection with that company to accept the position as southern California manager for the Bethlehem Steel Corporation. About the first of January he will open an office in the Washington Building, Third and Spring Sts., Los Angeles, Calif., for the Bethlehem Steel Corporation, covering all of southern California and Arizona.

In the study of molybdenum and cerium alloy steels at the Ithaca, N. Y., field office of the Bureau of Mines, endurance tests on bars taken both with and across the direction of rolling show that the relationship between endurance and tensile strength (or hardness), which holds fairly closely for longitudinal bars, does not hold nearly as well on transverse bars. The endurance of transverse bars is lower, and the amount by which they are lower appears to depend primarily on the type, size, number and distribution of the non-metallic inclusions.

The Central Steel Company, Massillon, Ohio, has issued a 44-page booklet giving a brief story of the evolution of the alloy steel industry, and listing many parts for which alloy steels are used. Numerous charts are included giving chemical and physical characteristics of many most generally used alloy steels. Specifications are also given of some of the special alloy steels made by this company.

The effect of tempering a special hardened tool steel at 150 to 500 degrees Cent. upon its resistance to wear when worn against the same steel in the hardened condition, has been studied recently by the United States bureau of standards. Under the particular conditions of the test, the preliminary results indicate that the tempered steel shows less wear than the hardened steel.

T. C. Sherman, for the past several years assistant to the general sales manager of the Ludlum Steel Co., Watervliet, N. Y., has been transferred to Cleveland as district manager of sales, covering Ohio, Kentucky, and western Pennsylvania. His headquarters are in the Guardian building, Cleveland. W. M. Vrooman is now assistant to the general sales manager, P. A. E. Armstrong.

An alloy of chromium and iron known as "Duraloy" has recently been placed on the market by the Cutler Steel Co., Pittsburgh, Pa., with a general sales office in the Hudson Terminal Building, New York, N. Y. The chief feature of the alloy is resistance to oxidation, corrosion and abrasion, although it possesses other properties that adapt it to special uses.

C. H. Wills & Co., Marysville, Mich., manufacturers of the Wills-St. Claire car, have been granted a friendly receivership through the United States courts by the appointment of the Security Trust Co., Detroit, as receiver. The Michigan Malleable Iron Co., Detroit, instituted proceedings in behalf of the company. The application for a receiver came after many conferences with most of the principal creditors and Eastern bankers. Although the company is said to be solvent, this process was deemed expedient in order to re-finance and conserve the best interests of all concerned.

A. L. Meyers, who has been connected with the R. K. LeBlond Machine Tool Company, Cincinnati, for the past sixteen years, has been transferred from the General Superintendency of that Company to the sales force of the same corporation and will have charge of the field work. Mr. Meyers has been Vice-Chairman of the Cincinnati Chapter for the past two years and was acting Chairman last year.

Temperature

With the **F. and F. Optical Pyrometer** the temperature is measured by merely observing the object. It is accurate, simple, substantial and direct-reading.

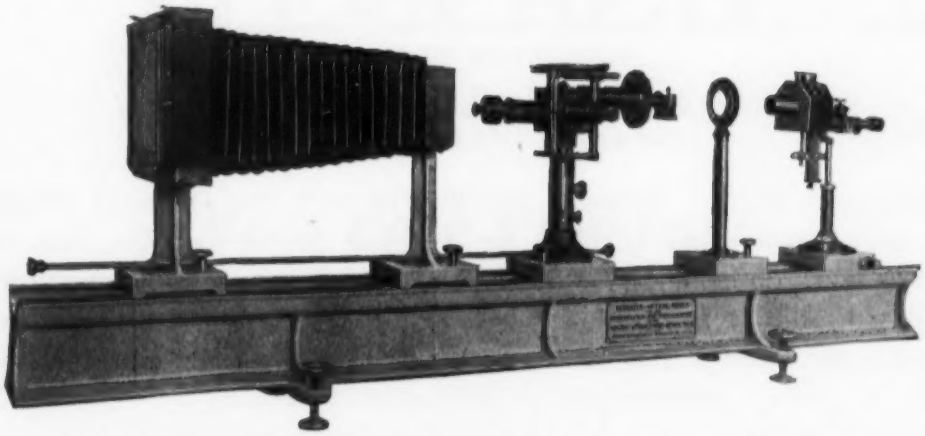
(Write for Booklet)

Hardness

The **S. M. Co. Brinell Machine** is the standard machine for measuring hardness of metals adopted by the leading concerns.

Pressure is applied quickly and uniformly; a special feature prevents leakage of the hydraulic fluid.

Micro-Structure



The **Scimatco Optical Bench** is the advanced outfit used by many of the foremost metallurgical firms for observing and photographing the micro structure of metals.

SCIENTIFIC MATERIALS COMPANY

"Everything for the Laboratory"

PITTSBURGH, PA.

Frank Hoffstetter, who has been assistant superintendent of the R. K. LeBlond Machine Tool Company, Cincinnati, has resigned his position to go with the Seifert & Woodruff Company of Cincinnati. He will have charge of the sales end of their machine tool supplies. Mr. Hoffstetter is Chairman of the Cincinnati Chapter Asst. Committee on Constitution and By-Laws.

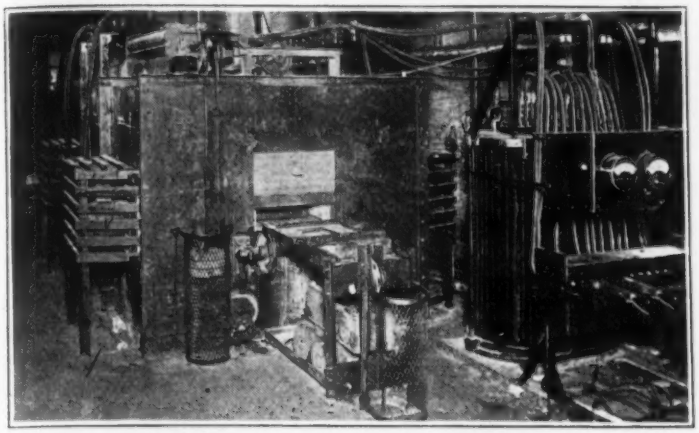
Frederick G. Hughes, vice president of the New Departure Mfg. Co., Bristol, Conn., has been elected president of the Bristol chamber of commerce.

The Jones & Laughlin Steel Co. shortly will be reorganized and the name changed to the Jones & Laughlin Steel Corporation, while the capitalization now standing at $30,000,000, all common stock, will be increased to $120,000,000, of which $60,000,000 will be 7 per cent cumulative preferred stock and $60,000,000 of common stock. A limited amount of the preferred stock is to be offered the public and by this move the Jones & Laughlin company, which has been a closed corporation, becomes an open one.

Application for a charter under the laws of Pennsylvania for the new corporation has been made and all details for these changes have been completed and wait only formal action of the stockholders and directors at a meeting to be held this week. The management of the company will not be affected in any way by this transaction.

Raymond Desner, formerly metallurgist with the Diamond Chain Company, Indianapolis, and later of the Hudson Motor Car Co., has resigned his position with the latter company and has accepted employment with the Detroit Edison Company. Mr. Desner's new work is in the Right-of-Way Division. Mr. Desner has best wishes for success in his new line of work.

Richard A. Topham, a member of the executive committee of the Schenectady Chapter, has recently received a fine promotion and has been advanced from his position with the General Electric Company at Schenectady to a very responsible position in the plant of the same company located at Lynn. This necessitates Mr. Topham's transfer from the Schenectady to the Boston Chapter.



Electric Steel Treating Furnace insulated throughout with SIL-O-CEL

To Secure Uniform Heat and Positive Temperatures

apply to your furnaces a layer of SIL-O-CEL Insulation.

SIL-O-CEL is light in weight, highly siliceous, and possesses the lowest heat conductivity of any known material. It withstands extremely high temperatures, acting as a barrier to heat flow through walls and settings, and making it possible to regulate heat with absolute accuracy. Furnished in the form of brick, block, powder and cement, adapted to all types of equipment without change in design.

Complete information contained in Bulletin F-8B sent with blueprints and samples upon request.

CELITE PRODUCTS COMPANY

NEW YORK - 11 BROADWAY · DETROIT - BOOK BUILDING · DENVER - SYMES BUILDING
PHILADELPHIA - BULLETIN BLDG · CHICAGO - MONADNOCK BLDG · LOS ANGELES - VAN NUYS BLDG
CLEVELAND - BULKLEY BLDG · ST. LOUIS - RAILWAY EXCHANGE BLDG · SAN FRANCISCO - MONADNOCK BLDG
MINNEAPOLIS - 251 SIXTH AVENUE, SOUTH · NEW ORLEANS - WHITNEY CENTRAL BANK BUILDING

SIL-O-CEL

PREVENTS HEAT PENETRATION

TRADE MARK REGISTERED U.S. PATENT OFFICE

A CELITE PRODUCT

KLEAN HEAT

(TRADE MARK REGISTERED)

(a reheating mixture for hardening steel)
Means just what the name says.

Other Park Products:

Carbonizing Compounds.
Lead Pot Carbon.
Cyanide Hardening Compounds.
Kwick Kase.
Quenching and Drawing Oils.

Park Chemical Company

Detroit, Mich.

It has been reported that it is probable that the Youngstown Sheet & Tube Co. will acquire the Brier Hill Steel Co., this city one of the largest independent sheet makers in the country. This announcement was made Tuesday afternoon by President James A. Campbell, of the Sheet & Tube company, following a directors' meeting. He explained that details are still to be worked out and recommendations made by the boards of the two companies to their stockholders. Holders of Brier Hill common stock will be paid in the common stock of the Sheet & Tube company while the latter will assume the bonded and preferred obligations of the Brier Hill company.

Directors of the Sheet & Tube company increased the common dividend of the last quarter to $1 per share. Last quarter the company distributed 75c per share. They also authorized the regular preferred dividend of $1.75. Both dividends are payable Jan. 1 to holders of record Dec. 20.

The Firth-Sterling Steel Co., McKeesport, Pa., has added to its line the Globe polished drill rods drawn by the Globe Wire Co., of Sharpsburg, Pa. These rods are made from steel produced by the Firth-Sterling Steel Co. Complete stocks of Globe drill rods are now carried in the Firth-Sterling Steel Co.'s New York, Boston and Philadelphia warehouses.

In bulletin 221, the Cutler Steel Co., of Pittsburgh, describe "Duraloy," a chrome-iron alloy intended for any purpose where resistance to oxidation, corrosion, and abrasion is important. This alloy is of particular value for furnace parts and heat-treating equipment, such as annealing and carburizing boxes, baskets, lead pots, and pyrometer protection tubes. It also finds general employment in chemical plants and for pumps where resistance to corrosion is of importance, and for extrusion and drawing dies and other parts where abrasive resistance is of value.

Earle M. Hayes, formerly general manager of and for the past five years with Hunter & Havens, steel, iron and mill supply merchants, Bridgeport, Conn., has just been appointed general manager of steel sales of the American Tube and Stamping Co., Bridgeport, Conn.

After extended discussion of the problem involved in the numbering of steels, the conference called by the American Engineering Standards committee, at the request of the bureau of standards, decided the matter could be handled better by a sectional committee of the American Engineering Standards committee. For that reason no plan or program was adopted so that the sectional committee could consider the matter without limitations as to whether the classification be based on chemical analysis, heat treatment or physical tests.

SIMONDS
STEEL
CRUCIBLE —— ELECTRIC

High Speed Steel
Magnet Steels
Chrome Ball and Bearing Steels
Carbon and Alloy Tool Steels
Special Steels

TO know that the steel ordered today will duplicate in every respect that which gave unusual efficiency six months ago, is a satisfaction to the consumer made possible only by years of experience in making QUALITY Steels UNIFORM at all times.

SIMONDS STEEL in your hardening room allows you fixed temperatures in heat treating and eliminates those costly "trouble days".

We Develop Steels Required
For Particular Hard Usage

Bars Sheets Billets

SIMONDS MANUFACTURING CO.
STEEL MILLS
LOCKPORT, N. Y.

Edgar T. Ward Sons Co., Distributors

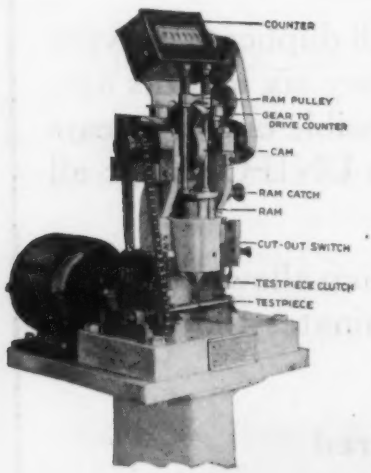
After careful study of the possibilities of electric steel, The Union Electric Steel Co., of Carnegie, Pa., has decided to specialize in the drop forge supply business, diverting its complete equipment to the manufacture of die blocks, trimmer steels, piston rods, rams, sow blocks, and shoes; and has acquired the services of B. E. L. DeMare, who will act in the capacity of general manager; W. H. Rieger, metallurgical engineer in charge of production; W. L. (Pete) Goodrich, sales manager; Ross J. Emery, assistant sales manager.

The above gentlemen are well known throughout the drop forge field and will now be in a position to render an ideal service to their customers.

Robert W. Mayer, who has been the efficient manager of the Brown Instrument Co. at their Cleveland office, 1131 Guardian building, has been transferred to the Detroit district.

Mr. Francis Q. Thorp will have charge of the Cleveland territory, and his office is located at 1131 Guardian building.

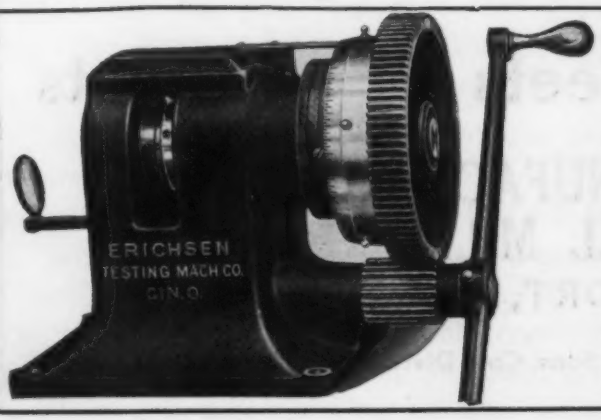
J. K. Haynes, formerly engaged in metallographic research at the naval engineering experimental station, is now located with Willys-Morrow Co. of Elmira, N. Y., and is engaged in their metallurgical department.



Impact Testing Machine

Best method for Impact Fatigue Tests and resistance to shock. A radical departure from the old pendulum and single blow machines. High speed machine parts should be tested under conditions approximating actual use. Especially recommended for Automobile, Airplane and Railroad material.

PITTSBURG INSTRUMENT & MACHINE CO.
Pittsburg, Penna.
Brinell Testers **Sheet Metal Testers**



Erichsen Testing Machines Standard the World Over

For the Determination of the Drawing, Stamping, Compressive and Folding Qualities (the "Workability") of Sheet Metals.

Know your Metal.
Save time and save money.

The Bock Machine Company
3618 Colerain Ave. Cincinnati, O.